FOREST AND WATER PROBLEMS OF CALIFORNIA

Vol. XI—No. 8 AUGUST, 1905 $1.00 a Year; 10 cts. a Copy

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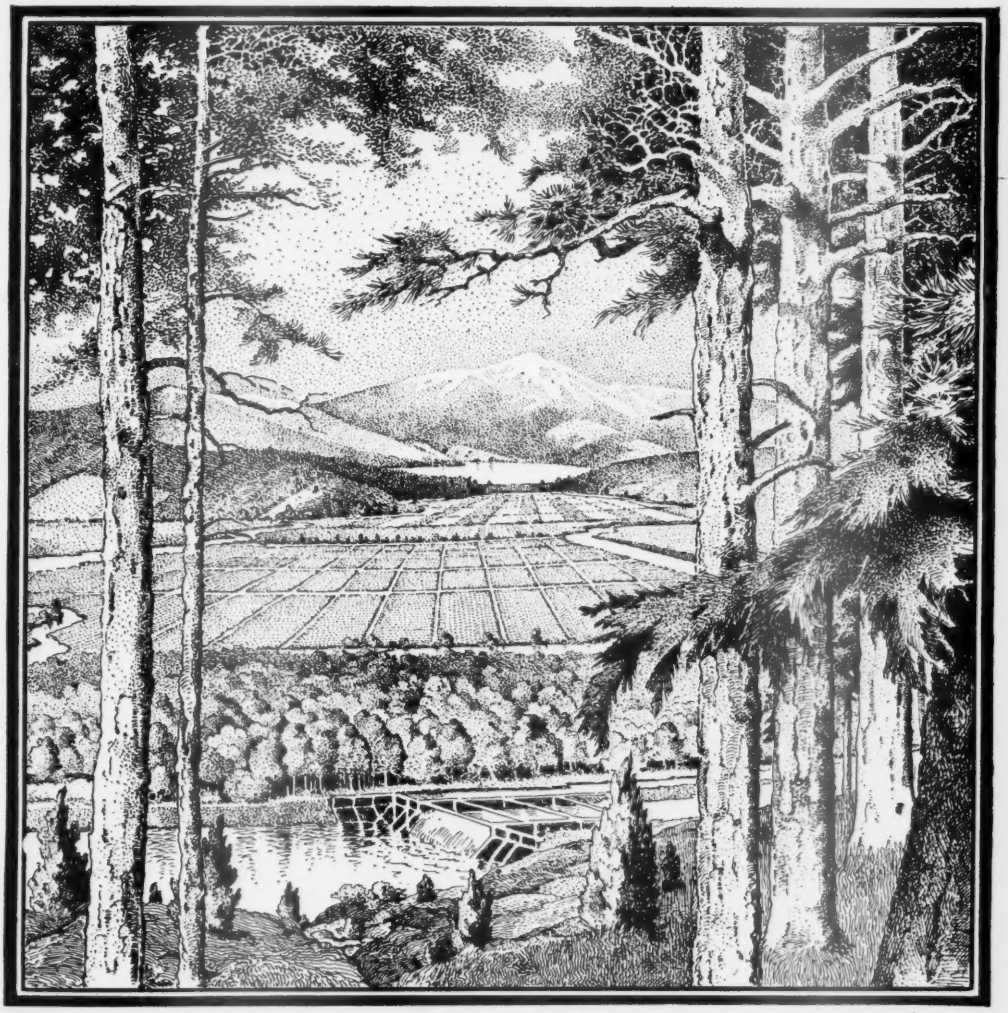

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Forestry and Irrigation

H. M. SUTER, Editor

CONTENTS FOR AUGUST, 1905

REDWOOD LOGGING - - - - - - - - - *Frontispiece*

NEWS AND NOTES (*Illustrated*):

Special California Number 341
Reclamation Work in Southwest - - - 341
Coke Company to Plant - 341
New Use for Virginia Pine 342
Planting to Preserve Water Supply - - - - 342
Forest Inspectors - - 342
Planting for Shelter Belt - 342
Examining Mineral Claims - 342
Forest Plantingon Watershed 343
Trouble on Colorado River - 343
Purchase Irrigation Works - 344
Michigan Forestry Association - - - - - - 344

THE FOREST SITUATION IN CALIFORNIA. By Gifford Pinchot - - - - - - - - - - - - - 345

WORK OF THE RECLAMATION SERVICE IN CALIFORNIA. By F. H. Newell - - - - - - - - - - - 346

REFORESTING IN CALIFORNIA. By T. P. Lukens - - 347

GENERAL OUTLOOK FOR RECLAMATION WORK IN CALIFORNIA (*Illustrated*). By J. B. Lippincott - - - - - 349

FOREST FIRES AND THE FOREST IN THE CALIFORNIA SIERRAS (*Illustrated*). By William F. Hubbard - - - - 354

WATER AND FOREST ASSOCIATION (*Illustrated*). By T. C. Friedlander - - - - - - - - - - - 364

THE IRRIGATION INVESTIGATIONS IN CALIFORNIA OF THE OFFICE OF EXPERIMENT STATIONS. By Elwood Mead - - - - - - - - - - - - - - - 367

CALIFORNIA'S FOREST POLICY (*Illustrated*). By E. T. Allen 370

FIELD WORK IN IRRIGATION (*Illustrated*). By Samuel Fortier 371

THE INFLUENCE OF PRIVATE TIMBERLAND OWNERSHIP ON THE FOREST POLICY OF CALIFORNIA (*Illustrated*). By E. A. Sterling - - - - - - - - - - - 376

STUDIES OF CALIFORNIA GROUND WATERS. By W. C. Mendenhall - - - - - - - - - - - - 382

THE FOREST RESERVES OF CALIFORNIA. By A. F. Potter 384

HOW THE COMMERCIAL ORGANIZATIONS OF CALIFORNIA COOPERATE WITH THE MOVEMENT FOR GOVERNMENT RECLAMATION (*Illustrated*). By Hamilton Wright 387

THE SIERRA CLUB (*Illustrated*). By William E. Colby - - 391

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JOHN E. SHERIDAN

REDWOOD LOGGING

"Fallers" making the undercut, Caspar, Mendocino County, California. After this has been done and the bark cut away, a saw is used.

Forestry and Irrigation.

VOL. XI. AUGUST, 1905. No. 8

NEWS AND NOTES

Special California Number

The greater part of this issue of FORESTRY AND IRRIGATION is given up to a discussion of the forest and water problems of California. No state in the country offers a more inviting field to the student of economic questions as affected by forests and waters; to the forest and irrigation engineers it presents many striking problems, and on their skill in solving these problems much of the future prosperity of the state depends. In this number there is a series of notable articles by the experts in charge of the California work that deserve close reading. They outline very fully the work now going on, and that to be taken up later.

This California number, by the way, follows the plan begun last month of treating in particular of the forest and water problems of a single state, with a view to their better understanding. In July the forest situation in Connecticut was discussed; next month the proposed Appalachian Forest Reserve will receive special notice. The October issue will deal at length with Minnesota forests, and in November Maryland will be taken up.

Reclamation Work in Southwest

Mr. B. M. Hall, supervising engineer of the U. S. Reclamation Service in charge of operations in New Mexico, Texas and Oklahoma, reports that field work in the valley of the Rio Grande has been suspended on account of flood conditions, but the surveys have already been carried to such a point that plans and specifications are being prepared for the main canal in Mesilla Valley.

Water users are fully awake to the benefits which will acrue to them with the completion of the government irrigation system, and are eager to cooperate by pledging their lands through the Water Users 'Association formed for the purpose in both Texas and New Mexico.

Both the Rio Grande project and the Yuma project on the Colorado River in Arizona and California, involve complicated international questions, and it is probable that a draft for a treaty between the two countries will be submitted for the consideration of the Department of State in the near future.

Work on the Hondo project under the contract of the Taylor-Moore Construction Company, which has been taken over by the United States, is partially completed. Recommendations have been made that the contract for constructing the earthwork on embankments 3 and 4, consisting of about 200,000 cubic yards, be relet. It has been decided to finish the remainder of the work on force account. Plans have been completed for the canal system under this project, and final surveys are being made.

Rapid progress is being made in the investigation looking to the practicability of purchasing the irrigation system at Carlsbad.

Two field parties are at work on the Navajo project, Oklahoma. It is estimated that the Navajo reservoir on the North Fork of Red River, will conserve a water supply sufficient for the irrigation of nearly 75,000 acres.

Coke Company to Plant

The Forest Service has received an application for a planting plan from the H. C. Frick Coke Company, of Uniontown, Pa., which has several

thousand acres of land in Westmoreland, Fayette, and Greene counties, Pa. Part of this land is under cultivation, and the rest is idle owing to the coal having been taken out. None of it is very profitable, and the company is proposing to plant trees on it. Such rapid growing varieties as are suitable for fence and pit posts are desired. It is also proposed to plant such varieties as will yield good sized timbers in fifty or sixty years. Mr. S. N. Spring, Forest Assistant, has been detailed to make the preliminary examination for this company .

New Use for Virginia Pine The Virginia pine, commonly known as scrub pine, is no longer regarded as worthless except for cordwood. Within the last four years the manufacturers of wood-pulp have tried the wood with success, and several mills, in Pennsylvania especially, are using it in considerable quantities for this purpose. One Pennsylvania mill consumes in this way 20,000 cords a year.

The scrub pine, whose range is chiefly in Tennessee, North Carolina, Kentucky, Maryland and Virginia, is found in large quantities in old fields in the last two states in particular, where it has reproduced itself, unheeded since the Civil War. It has recently been found in commercial quantities also in central Pennsylvania. Since it is a tree which thrives on even the poorest soil, and reproduces itself with great ease, its entrance into commercial importance will offer a very interesting problem in forest management, and one which promises quite unexpected results.

Planting to Preserve Water Supply The Forest Service is preparing to plant a large area of denuded land in the new additions to the Gila River Forest Reserve near Ft. Bayard, N. Mex. The main purpose of the proposed planting is to preserve the water supply for the great military hospital at Ft. Bayard. A nursery nine-tenths of an acre in area has been established and a party of four men is now making a detailed study of the proposed planting sites in the reserve, in order to prepare the planting plans.

Forest Inspectors The present assignment of forest inspectors on the National Forest Reserves is as follows: E. S. Bruce, the Big Horn Forest Reserve, in Wyoming; Smith Riley, the Leadville Forest Reserve, in Colorado; Elers Koch, the Madison Forest Reserve, in Montana; J. H. Hatton, the Sevier Forest Reserve, in Utah; and R. E. Benedict, the Prescott Forest Reserve, in Arizona.

Planting for Shelter Belt The buying of the neglected or abandoned farms in New England for summer homes by city people is leading to forest planting in certain of the old fields for protection, ornament, or economic purposes. The Forest Service has recently given assistance along this line by preparing a plan for a shelter belt on an estate owned by the Rev. Edward Everett Hale. The estate is in southern Rhode Island, near Wakefield, where the strong gales from Long Island Sound have full sweep over the country. A shelterbelt 40 feet wide composed of pitch pine, Norway spruce, and Scotch pine, will be planted on the windward side of the farm. The pitch pine, which is a species able to endure strong salt-laden winds, will be planted in the outer row, with the Norway spruce and Scotch pine back of it. These trees are so arranged that by their different rates of growth they will form a belt with a slanting top lowest to windward, so that the wind will be deflected above the fields which it is desired to protect.

Examining Mineral Claims Mr. Alexander C. Shaw and Mr. G. W. Woodruff, of the Forest Service; Mr. Frank Bend, of the General Land Office; and Mr. A. E. Chandler, of the Reclamation Service, are visiting several of the forest reserves for the purpose of inspecting and reporting on mineral and other claims.

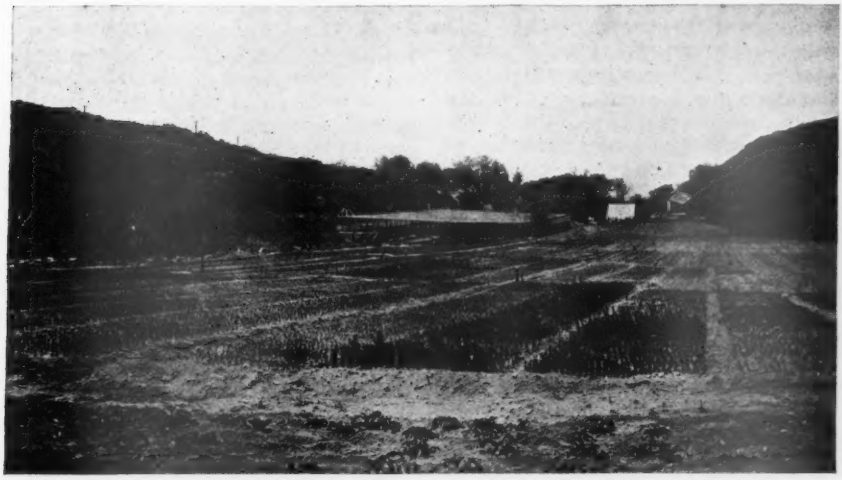
Forest Planting on Watershed

A representative of the Forest Service recently visited the nearly completed reservoir of the Metropolitan Water Board at Clinton, Mass., where extensive forest planting work is being carried on. This reservoir and dam is one of the largest in New England, and to insure sanitary conditions at the sources of the water supply the adjacent region through which the streams flow has been acquired and is under the management of the board. Part of this area is covered with natural timber; other portions are barren or brush covered. Upon the open lands forest planting is being done.

The planting work has been going on for about four years and approximately 200 acres are planted annually. The species thus far used are white pine, chestnut, maple, and hickory. On some of the brush covered areas white pine seedlings were planted 10 feet apart and hickory nuts planted between them. In other places sugar maple seedlings have been mixed with the white pine to act as a lowerstory to the more rapid growing evergreen tree. On one field a series of experimental plantations have been made in which the several species are planted at various distances apart and in mixtures which are intended to give the best forest conditions at maturity. In order to supply material for these field planting operations, two forest nurseries have been established, one for the production of evergreen trees and one for hardwoods.

Trouble on Colorado River

A combination of peculiar topographic features and prolonged floods has wrought great havoc in southern California and southwestern Arizona, and still greater calamity threatens the settlers unless immediate steps are taken to keep the Colorado River between the banks of the original channel.



Henniger Flats Nursery, San Gabriel Forest Reserve
(See article in this number by T. P. Lukens)

The silt borne down from the mountains through past centuries by the Colorado River has built up a great delta, cutting off an arm of the sea and gradually raising the river bed till the water flows on a ridge nearly 400 feet above the basin, which has long since been dried out by evaporation.

In 1904 the California Development Company cut a canal about four miles below the Mexican boundary, opening

a short cut from the river to their main canal. No headgates were provided, and during the high water period of the past winter the banks of the canal eroded and the ditch deepened until over 50 per cent. of the flow of the river was running through the canal into Salton Sink. Unsuccessful attempts were made to shut off the flow into the canal, and there is a grave possibility of the river abandoning its present channel to the Gulf of California and forming an inland sea in Salton Basin.

The flooding of this basin means the possible submergence of the Imperial Valley with the farms, homes, and other improvements of nearly 8,000 people in California, also of settlements on the Mexican side, and the destruction of 120 miles of the Southern Pacific Railroad, a transcontinental line.

Opposite the heading of the canal through which the water is now rushing lies a long island, and an attempt is being made to divert the river to the east channel around this island by a dike about 3,000 feet up stream from the canal heading. This diversion, if successful, may work serious injury to the Yuma irrigation project as now planned by the engineers of the U. S. Reclamation Service, but if the river is properly handled it is believed the damage will be slight compared with the greater evil of allowing it to flow into the Sink.

As the greater part of the danger and loss will occur in the United States, steps are being taken to perfect protective measures immediately.

Purchase Irrigation Works

The Secretary of the Interior has approved the option to purchase the property of the Klamath Falls Irrigating Company, known as the Ankeny Ditch, for the sum of $50,000.

This ditch will be enlarged and improved by the government, and a large part of it ultimately will be used as the upper end of the main canal of the Klamath project.

The Secretary of the Interior has authorized the purchase of the Little Klamath Water Ditch Company's rights and property, known generally as the Adams Ditch, for use in connection with the Klamath Falls irrigation project. This ditch system is to be used as a part of the project and the agreement to sell includes also certain color of right to lands now under water, and wihch are to be drained and used for irrigation purposes.

The Secretary has also approved the purchase of certain rights and property of the Jesse D. Carr Land and Live Stock Company from Mr. S. L. Akins. This purchase involves a large area of land for the Clear Lake reservoir site also rights of way for ditches to be constructed by the United States over these lands and certain color to right of lands now under water which will be drained and irrigated.

The former purchase is to be made for the sum of $100,000 less certain deductions stipulated in the agreement, and the latter for the sum of $187,500.

Michigan Forestry Association

The organization meeting of the Michigan Forestry Association will be held at Grand Rapids, Mich., August 29 and 30. Preliminary organization of the association was effected some months ago, through the efforts of a number of those interested in forestry in the state, and the work of the association has been carried on by provisional officers. The coming meeting is arranged primarily to affect a permanent organization, and it is intended that its sessions shall be of particular interest to the Michigan business man. The topics for discussion have been selected with a view to this, and all speeches will be limited to five or ten minutes, in order that as many opinions as possible may be heard. A large number of those in the state interested in forestry, lumbering, railroading, etc., will be present, and the indications are that the meeting will be a successful one in every respect.

THE FOREST SITUATION IN CALIFORNIA

BY

GIFFORD PINCHOT
Chief. U. S. Forest Service

THE essential facts about the forest situation in California are three:

First, the state has passed a forest law, and under it a state forester of character and training has been appointed. Nothing could be more hopeful.

Second, good progress has been made in securing an area of land for government forest reserves more nearly sufficient than in many other states to protect and care for the interests which, in the absence of the reserves, must suffer.

Third, and most important of all, the necessity for forest preservation by wise use is more generally understood in California than almost anywhere else, and the people are more ready to act upon that understanding.

The comparatively favorable situation in forestry which these three facts indicate has not been brought about without vigorous and long continued effort by citizens of California. The Water and Forest Society, through the effective agitation it has carried on, and the vigorous campaign it has made before the legislature, as well as before the people of the state, is entitled to very great credit. Without the assistance of Governor Pardee much of the progress of the last two years would never have been made. The activity of the Sierra Club has been of great value. So has that of the Water and Forest Society of southern California; and individual men and women, far too numerous to mention here, have unselfishly and energetically given their time and effort to this paramount interest of the state.

To call the forest interest the paramount interest might, at first sight, seem unjustified; but if it is fair to call an interest paramount when nearly all of the other interests of the state depend directly upon it, and must suffer if it suffers, then certainly the forest interest of California is paramount. Without its forests, the great interests of the state in irrigation would dwindle and fade. Without its forests, the mines of California would cease to be operated; the railroads would either stop running or they would be run at almost prohibitive expense. Of course the vast lumber business of the state would vanish. Stock raising without the summer range in certain of the forest reserves would be impossible in its present form. In a word, in California and in every other timbered mountain state, it is the forest which underlies the general prosperity, and California is most fortunate in having an understanding of this great fact so widespread among its people.

One most fortunate outcome of this public feeling, if I may be allowed to call it so, was the coöperation which the state undertook with the Bureau of Forestry of the United States Department of Agriculture more than two years ago, and which is to be continued for two years longer. Among the results of this coöperation, many of which are almost ready for publication, are a forest map of the state, with descriptions of the different types of forest trees; studies of the sugar and yellow pines; studies of the functions of chparral in its relation to the reproduction of the forest; studies of the reproduction of timber trees; and a very important study of forest fires, and of the means for preventing them.

In addition to these results, there are others less well defined but not

less important. As a single example: lumber companies have become interested in conservative lumbering as a result of the coöperative work, and several of them have either adopted systems as a part of protecting their lands from fires, or are on the verge of doing so.

During the next two years the studies of forest fires and of important lumber trees are to be continued, while the tests of California coast timbers, already under way at the State University, will be continued and extended. Special attention will be given to questions of tree planting, and further studies of the effect of the forest on water supply will be made.

WORK OF THE RECLAMATION SERVICE IN CALIFORNIA

BY

F. H. NEWELL
Chief Engineer, U. S. Reclamation Service

THE State of California, with its immense area and diversity of physical conditions, has offered tempting opportunities for investigations and survey by the Reclamation Service. At the same time, the relatively high state of development of the arid portions of California have resulted in a complication of private rights which have made construction by the government notably difficult. California has been the pioneer in irrigation development, and being in part humid and part arid, it has been for years the battle-ground between two radically opposite and contending ideas regarding water ownership. The complications which have resulted are such that the government in its large work has been compelled to proceed with great caution.

Throughout the state irrigation development has proceeded rapidly and individuals and corporations have built many large works. California, especially the southern part, has for several years offered examples of elaborate hydraulic construction, and students of irrigation, as well as experienced engineers, have come from abroad and from all parts of the arid west to study the examples there to be found. On the passage of the Reclamation Act of June 17, 1902, conferring authority upon the Secretary of the Interior to construct large works in California and elsewhere, it was apparent that any such construction must be very carefully considered with reference to all vested interests.

The extent and ramifications of these vested interests is a far more difficult fact to be ascertained than many of the physical conditions. It is possible to survey reservoir sites and bore for foundations for dams, obtaining promptly and with certainty the physical conditions; but to ascertain the title to or ownership of the land which may be involved in the work, and particularly of the waters, is by no means as direct a matter, and frequently long and vexatious litigation must ensue before the essential conditions of ownership can be established.

The irrigation resources of California were by no means unknown on the passage of the Reclamation Act. Since 1888 the Hydrographic Division of the Geological Survey had been systematically studying the opportunities; had measured streams, surveyed catchment areas of the rivers in the mountains; had made maps of portions of the irrigable lands; had ascertained the flow of many of the important sources of supply; and, in short, had brought together many of the es-

sentials as to the extent to which the arid lands might be reclaimed. With this large mass of information at hand, supplemented by further studies, the Reclamation Service has endeavored to pick out the localities where the largest results might be obtained and the public most benefited. It so happens that the conditions were most favorable on the extreme north and south. The Colorado River, the largest stream of the arid region, was first considered. Maps were made of the irrigable land in the valleys along its course and full consideration taken of the opportunities presented. As a result, the so-called Yuma project was first worked out and presented for approval of the Secretary of the Interior.

In the far north, and lying partly in Oregon, is the Klamath project, where there is also an abundance of water and a vast extent of arid land. Here, also, the conditions seemed most favorable for producing prompt results, and in turn the Secretary of the Interior has conditionally approved construction.

At about the center of the State and east of the great mountain range, there was found to be, in the Owens Valley, an excellent body of irrigable land with a somewhat uncertain water supply. Here, also, there appeared to be an opportunity for successful reclamation and efforts have been concentrated on ascertaining the available supply preliminary to considering construction.

The great problem of the future, however, as regards the entire state, is the best use of the water of the great interior valley, including the Sacramento on the north and San Joaquin on the south. After results have been attained at Yuma and Klamath, it is believed that the storage and control of the headwaters of the Sacramento and San Joaquin is the greatest which can be undertaken by the government and by the state. As preliminary to such operations, it is necessary to obtain facts as to river flow extending over several years and to make surveys of almost innumerable reservoir sites and points of storage for diverting waters. For this reason investigations are being continued throughout the great valley of California, and it is hoped that upon the completion of the great projects on the north and south efforts may be concentrated toward the solution of the problem of river control in the interest of irrigation, and incidentally, in that of all other industries in the state.

REFORESTING IN CALIFORNIA

BY

T. P. LUKENS

THAT the first effort to reforest the mountain water-sheds should be made in Southern California, is natural, because there exists the greatest need, owing to the never abundant forest covering having been destroyed by irrational use, fires, and stock grazing. In consequence of the depletion of the brush and trees on the mountain slopes, surface streams have greatly decreased in volume, and in many cases the flow has entirely ceased in summer, succeeding floods in winter.

The destruction has been on the increase until quite recently, while the demand for water has been rapidly increasing. Irrigation in any form is practically on but one acre in 6½ acres of the arable land in Southern California, and the water is used to its fullest capacity. Not only is all stream flow used, but every effort is being made to secure water by tunnel-

ing into the mountains, sinking wells, and raising water by pumping at an enormous expense. The actual value of property in the seven southern counties of California, is over $500,000,000. If there were sufficient water for all of the arable land, the wealth would be increased to approximately $3,250,000,000. It is to secure as far as possible this great increase in wealth and make it possible for 2,000,000 people to build and maintain homes in the most delightful and beautiful spot in America, that has induced the United States Forest Service to undertake the difficult task of reforesting the mountains.

First of all in importance, and a matter that should precede planting operations, is a systematic preparation of the mountains by making fire-breaks. This is done by removing the growth from the main and most lateral ridges so as to confine the fires to narrow limits. This is being done, and as it is purely mechanical, completion is only a question of available funds. If only this were done and the danger of fire removed, the increased growth by natural methods would in many fold repay the outlay by the consequent increased water conserving power. There can be no water secured in Southern California for irrigation except that which falls on our mountains, and the quantity to be had for use in summer depends upon the character and density of the growth. What to plant, and how to care for that which is planted, is a problem the Forest Service is studying with great earnestness.

In the selection of species for planting, we are keeping as closely as possible to nature. We note carefully what species she has planted on the various slopes; examine carefully the climatic and soil conditions and altitude where each species is found flourishing.

On the most parched and barren slopes chaparral is best adapted. Chaparral is of great value in preventing erosion, to some extent cooling the surface, and acting as a nurse for the trees, which must be returned to the water-sheds to insure a water supply at all adequate for future demands. The factor that makes the task most difficult in reforesting, is the slight rain fall.

During the winter of 1902-'03, we planted a large quantity of seed in small beds over the mountain slopes. The rain was sufficient to germinate the seed, but the rain ceased early in March and no more fell until February, 1904. Many trees were living six months after the rains ceased, but at the end of eleven months of drouth, but few were left. Besides the long dry spell, an infinite number of small creatures, such as rabbits, linnets, and rats, preyed upon the little trees. We did not feel so badly over this loss when we observed that of all the billions of seed sown by nature after germinating and promising well, withered and died.

Passing over the stages of experiment through the drouth years, which have been of great value, the plan now is to grow the trees one summer under lath shade of ½ density, where we can care for them; and during the winter months transplant them in beds in the open ground. During the second winter, the idea is to transplant on the mountain sides where they are to grow permanently, all the trees that are strong of root and top, and not less than 12 inches high. The weaker seedlings must be transplanted and kept another year under training. The main object in having them large is, that the rabbits, of which there are many in the chaparral, will cut the little seedlings off close to the ground. The larger trees may be cut off several times, but are well supplied with dormant buds, and will send out a fine spreading top.

Places are prepared for the trees where they are to grow permanently, by digging a space 1½ or 2 feet across and 1 foot deep, if possible on the north side of a bush. The spot is marked by tying a rag on the bush nearest the bed, to enable the planter to find it. These beds are made in the fall or early winter that the ground may have time to settle. As soon as

rains have wet the beds thoroughly, trees are carried in deep cans or pails in which there is sufficient water to submerge the roots, and but one taken out at a time. To permit the roots of conifers to dry is to destroy them. The tree must be planted carefully, and the dirt well packed about the roots, leaving the tree in center of a little basin which we fill with litter or mulch, to assist them in weathering the long dry months. It will be useless to plant late; they must have the benefit of the winter rains to establish a good root growth.

In selection of species, little regard is paid to their economic value as a lumber tree. What is needed is a great mass of large roots to form innumerable dams beneath, and a spreading dense growth to shelter the surface from sun and wind to prevent evaporation.

For the most exposed and desolate slopes we plant the knob cone pine (*Pinus attenuata*), indigenous on the poorest, hottest slopes of the mountains from the San Bernardinos to Shasta. It has the commendable trait of holding its seeds hermetically sealed in cones for the future, and the calamity that causes the death of the tree, liberates the seed to plant a greater area than existed before. The big cone spruce which once covered the greater area of our mountains below 5,000 feet, and is indigenous only in Southern California, is in great favor and will be used largely. Also the big cone pine (*Pinus Coulteri*), is desirable to plant with the above two species, on the hard places. On northerly slopes the incense cedar (*Libocedrus decurrens*), is used, also oaks. Above 5,000 feet we can use the various forms of yellow pine (*Pinus ponderosa*), sugar pine (*Pinus Lambertiana*), shore pine (*Pinus contorta*), and lumber pine (*Pinus flexilis*), though but few species will grow out of the zone in which we find them. However, the incense cedar, big cone, and knob cone are grateful for the opportunity to grow at any altitude.

We are experimenting with a few each of many exotic species of brush and trees; especially promising at this time are found to be deodar cedar (*Cedrus deodara*), Jerusalem pine (*Pinus halepensis*), and martime pine (*Pinus martima*).

Only long patient study and hard labor can bring success in this work. There should be funds for more extended and thorough work. The past winter has been favorable, as a good rainfall distributed over six months has rendered the trees planted last winter are promising well.

It is gratifying to know that the Department has faith in the ultimate success of our efforts to reforest, which they have shown by establishing other nurseries.

GENERAL OUTLOOK FOR RECLAMATION WORK IN CALIFORNIA

BY

J. B. LIPPINCOTT
Supervising Engineer, U. S. Reclamation Service

THE work of the United States Reclamation Service in California, at the present time, is confined chiefly to three principal areas, namely, the valleys of the Lower Colorado, Klamath, and Sacramento Rivers.

The Yuma project on the Lower Colorado River includes the valley lands of the Colorado and Gila Rivers in the vicinity of Yuma, Arizona, and portions of the Yuma Mesa which it is proposed to irrigate by pumping.

The Laguna Dam for regulating the water supply and controlling the silts of the Colorado River is to be of the Indian weir type, built of loose rock with cut-off walls of concrete and sheet piling. The dam site is about 12

U.S. RECLAMATION SERVICE.
MAP OF
STATE OF CALIFORNIA.
SHOWING
RECLAMATION PROJECTS.
Scale of Miles
J. B. LIPPINCOTT, SUPERVISING ENGR.
OREGON
KLAMATH PROJECT
236,000 Ac.
KLAMATH FALLS
CRESCENT CITY
SHASTA VALLEY
60,000 Ac.
ALTURAS
PITT RIVER
GOOSE L.
EUREKA
REDDING
BUTTE VALLEY
SACRAMENTO VALLEY
2,600,000 Ac.
OROVILLE
RENO
TRUCKEE-CARSON PROJECT
460,000 Ac.
CARSON CITY
CLEAR LAKE
MARYSVILLE
WOODLAND
SANTA ROSA
SACRAMENTO
WALKER LAKE
STOCKTON
SAN FRANCISCO
GOLDEN GATE
MONO
YOSEMITE NATIONAL PARK
MODESTO
MERCED
MARIPOSA
SAN JOSE
SANTA CRUZ
HOLLISTER
MADERA
SALINAS
FRESNO
INDEPENDENCE
OWENS VALLEY
106,000 Ac.
OWENS L.
HANFORD
VISALIA
TULARE
BAKERSFIELD
SAN LUIS OBISPO
PACIFIC OCEAN
NEVADA
ARIZONA
COLORADO
BULLS HEAD RES.
NEEDLES
64,146 Ac.
SANTA BARBARA
VENTURA
CHEWHALL
LOS ANGELES
SAN BERNARDINO
RIVERSIDE
SAN MIGUEL
SANTA ROSA I.
SANTA CRUZ I.
SAN PEDRO
SANTA ANA
PARKER
153,000 Ac.
BLYTHE
102,000 Ac.
SANTA CATALINA I.
SAN NICHOLAS
IMPERIAL VALLEY
CLEMENTE I.
SAN DIEGO
YUMA PROJECT
MEXICO

miles above Yuma, where the river flows between two low walls of solid granite, and is the lowest site on the river where solid rock for spillways and abutments can be found. The total length of the dam is 4,780 feet, and the maximum height above low water is 13 feet. The settling basin formed by this dam will be approximately ten miles long, with an average width of two miles. Water will be drawn into the irrigation canals from the surface of this reservoir. The heavier sands and silts which settle to the bottom will be disposed of by sluiceways through the abutments of the dam, and below the grade of the regulating gates.

The overflow lands of the valley will be protected and the flood waters of both the Colorado and Gila Rivers controlled by means of dykes on either side of the stream.

The total area of irrigable valley lands on the Yuma project is approximately 90,000 acres, and the area of mesa land proposed now to be irrigated by pumping, from 20,000 to 25,000 acres. The reports of the Department of Agriculture on the Yuma lands show them to be very fertile. The silts of the Colorado River, which cannot be all removed, act as a fertilizer to constantly enrich the soil and keep it in a condition for a high state of cultivation. The climate of this area is such as to permit of the growing of certain crops throughout practically the entire year. Citrus fruits can be grown on the mesa under the proposed pumping system.

The sum of $3,000,000 has been set aside by the Secretary of the Interior for the construction of this project. The contract for the construction of the Laguna dam has been awarded by the Secretary of the Interior to J. G. White & Co., and it is expected that actual construction work will be begun at an early date.

The Klamath project is situated in Klamath county, Oregon, and in Modoc and Siskiyou counties, California. It includes the valleys of Lost River and of the upper portion of the Klamath River. The watershed area above the Klamath basin extends from the Sierra Nevada Mountains on the west to the Warner Mountains on the east, and north to Crater Lake. It includes within its area the Klamath Indian Reservation. The principal streams which drain this area are the Williamson and Sprague Rivers which empty into Upper Klamath Lake, and Lost River which empties into Tule Lake.

Upper Klamath Lake, together with its marginal swamp lands, has an area of about 100,000 acres. It is the headwaters of the Klamath River, and acts as a storage reservoir for regulating the flow of that stream.

Tule Lake, which receives the drainage of Lost River, has an area of over 90,000 acres. It is situated on the boundary between California and Oregon; it has no outlet.

Clear Lake, which with its marginal swamp lands, has an area of about 15,000 acres, is situated at the head of Lost River and is fed by Willow Creek. This lake acts as a storage reservoir in controlling the flow of Lost River, water flowing into it during the flood season, and out of it during the low stages of Willow Creek.

Lower Klamath Lake, also situated on the boundary line between California and Oregon, has, with its marginal swamp lands, an area of about 90,000 acres. Water flows into this lake from the Klamath River during flood periods of the river, and in the opposite direction when the river is at its lowest stages. A short distance below Lower Klamath Lake the river begins a series of steep rapids.

The peculiarities of the topography of this region, lend itself in a remarkable way to the economic reclamation and irrigation of this project. It is proposed to lower the waters of the Klamath River by a cut at the head of the rapids below Keno, sufficient to practically drain Lower Klamath and the marginal swamp lands, thus making them a part of the reclamation pro-

ject. The greater part of the water supply of Lost River will be conserved by storage, and used for irrigation. The flood and waste waters of this stream will be diverted from Tule Lake to the Klamath River, thus cutting off the water supply of this lake, which will rapidly shrink by evaporation and uncover large areas of irrigable lands.

Clear Lake and Horse Fly reservoir sites will be used for the storage of the present waters of Lost River. The former of these has a capacity of 462,000 acre feet, and the latter 157,000 acre feet. This water will be used for the irrigation of the Upper project, which includes Langells, Yonna, Upper Poe and Upper Klamath valleys, having an estimated net area of 48,356 acres.

For the irrigation of Klamath Valley, including the beds of Tule and Lower Klamath Lakes, the water supply of the Klamath River will be used; the diversion being made from the Upper Klamath Lake which will be used as a storage reservoir. The estimated total area irrigable from the Upper Klamath Lake is 188,045 acres, giving a total area of 236,401 acres in the entire project; of this area 90,000

MR. J. B. LIPPINCOTT

Supervising Engineer, U. S. Reclamation Service. Through his great ability as an engineer and his commendable public spirit he is rendering unusual service to the State of California and to the nation.

acres are in California and 146,401 acres in Oregon. About 45 per cent. of this area is still public land.

Surveys on this project were begun during the summer of 1904. Preliminary plans and estimates on the project have been prepared and approved, and the Secretary of the Interior has set aside the sum of $4,400,000 for the construction of the project.

The Sacramento Valley project contemplates the irrigation of the entire Sacramento Valley, so far as can be done without interference with navigation. The total area of this valley, exclusive of the Sutter Buttes and the channel surface of perennial streams, is 2,660,500 acres; of this amount 1,978,200 acres are above all overflow. Approximately 40,000 acres are now irrigated, while the area that can ultimately be irrigated probably exceeds 2,000,000 acres.

It is with a view of determining the most feasible plans for the irrigation of this vast area, that a study of the Sacramento Valleys has been undertaken upon the following lines: The Topographic Branch of the United States Geological Survey, in coöperation with the State of California, has undertaken the mapping of the entire floor of the valley, the Geological Survey having complete charge of the work, and the state paying one-half of the expense. The surveys for the portion of the valley west of the Sacramento River will probably be completed within the present year.

The Hydrographic Branch of the Geological Survey has established gaging stations on all the principal tributaries of the Sacramento, where the flood can be measured from 82 per cent. of the entire drainage of the basin. The drainage area tributary to this valley is approximately 26,000 square miles, and the estimated annual run-off is nearly 26,000,000 acre feet—enough to cover the entire floor of the valley over nine feet deep. The flow of the river from May to September, inclusive, is less than 24 per cent. of the total annual flow, a fact which shows the necessity of storing the winter flood waters.

For the purpose of storing the flood waters, six reservoir sites have been located and surveyed on the coast range streams, which enter the valley from the west, five sites on the Pit River and tributaries, and one site on the main Sacramento River at Iron Canyon above Red Bluff. Surveys are now in progress in the Puta Creek and Feather Rivers basins, where reservoir sites are known to exist.

The Forest Service of the Agricultural Department has taken up the study of the forest cover of the drainage basin and has made extensive withdrawals of the remaining public lands for forest reserve.

A Board of Army Engineers has been appointed to continue the study of the flood and overflow conditions of the Sacramento, together with the navigable capacities of the stream. This work is closely allied to the reclamation work as the construction of storage reservoirs will assist in the solution of both of the questions by taking care of the flood waters during the winter season, and preventing overflow, and by providing a supply whereby the summer flow may be maintained for irrigation, water power and navigation.

In conclusion, it may be said that California has before it a great work for the reclaiming of its arid lands, and that the Sacramento Valley presents one of the greatest, if not the greatest, opportunity for irrigation development to be found in the west.

FOREST FIRES AND THE FOREST IN THE CALIFORNIA SIERRAS

BY

WILLIAM F. HUBBARD

Late of the U. S. Forest Service

THE question of fires and their relation to the forest, future and present, is to a great degree occupying the minds of all those who are interested in the forest problems of California. The discussion of means to prevent the vital danger of forest fires has waxed strong in the press and forestry meetings. Many of those who consider the question of fire protection seem to favor a return to the so-called Indian method—in other words to repeated burning of the entire forest floor to prevent the accumulation of debris and consequent serious fires. When this is stated, in broad lines and with no saving clauses, the trained forester is bound to take exception to the entire argument. Yet when the case is presented fully and from all points of view, there is a broad meeting ground for every one concerned where a general policy may be decided on, satisfactory to all.

The first necessity is a clear statement of all the involved points. "The preservation of the forest from serious fire by a return to the old Indian burning" is a phrase most often heard in discussions bearing on the subject. It is argued that the Indians solved the secret of forest protection when they thus kept the forest clean of litter by repeated fires. That they prevented a general conflagration is at least likely, but before their system can be acceptcepted as worthy of imitation we must attempt to determine whether it is the best feasible method which will do most to improve the yield and quality of the timber, and enable the forest to bear the drain put upon it both by the present and the future.

The proper exploitation of the woods for civilized needs requires a more or less intensive system, and to contend that the Indian was acquainted with the principles of forestry is quite as preposterous as to say that the Indian of the middle-western plains was an agriculturist. To the savage the forest is but a collection of trees and a mere item in his surroundings, like the hills, precipices, and rivers. To civilization, the forest is a source of one of those great staples of supply which makes communal life possible, and, like all such, it bears a continually increasing value with the growth of population. From this it is quite evident that the Indian method must be of peculiar value, and clearly understood to its minutest details, if it is to be applied to the use of present complicated economic conditions. Nevertheless this much lauded system can only be stated in very broad lines and coupled with the most sketchy generalities.

That the Indians burned the forest floor is both the beginning and the end of the argument. But what is the method in detail? In what manner did the Indians burn and what was their object? To these definite questions come only the vaguest of answers. One of the leading San Francisco papers stated editorially that the lack of disastrous fires this summer was due to the fact that the woods have been entirely burned over in late years, and there was consequently nothing left to burn. Such is the opinion of a large per cent. of those who discuss the fire question. Added to this battalion of office table theorists is the regiment of old inhabitants. Those who have "lived in the woods for forty years, young man," and

should therefore know what they are talking about.

This paper will confine itself to northern California, and will attempt to prove in this region: first, that the Indian forest burning did untold harm to the forest, and, second, that such a method is absolutely indefensible for present conditions which call for the most careful and scientific regulation of fires.

INDIAN FOREST BURNING AND ITS EFFECT.

The trees themselves are witnesses to continued fires which have swept the California forests for an unknown period. Nor is there any doubt that most of these fires may be traced to the Indians.

A savage and nomadic people is mainly dependent on the chase, and in the lack of efficient weapons there is

Fig. 1. Old virgin forest replacing itself where fires have been absent

nothing better than fire as a method of driving game or of opening the forest that hunting may be easier. To this may be added the extreme likelihood of accidental fire. Small hunting parties, wandering through the mountains, gave infinite chances, in their utter carelessness, to spreading conflagration. In this manner, between design and accident, it is easy to see how a forest, tinder dry for five months, could be largely burned over in the course of a short period, and thoroughly swept of debris.

Fig. 2. Open forest with chaparral ground cover as result of continued fire

Granting, then, the prevalence of Indian fires and the partial cleanness of the forest floor as an effect, let us go on to determine at what cost this result was obtained.

Forestry would not be an art could it not study the present forest and from it give a fairly accurate picture of its original before it fell under the touch of man. Similar powers in in their line of work are acceded to the geologist, the biologist, and other workers in natural science, and must, perforce, be acceded to the forester.

The forests of the Sierras and Coast Range are composed of trees which grow with great vigor and which are mostly plentiful and regular seeders, showing themselves in every way adapted to the soil and moisture conditions. From this it follows that the trees normally grew in close order and formed a continuous forest cover. When the stand of timber in any locality waxed old and commenced to grow open in its decline, a young forest immediately began to take its place, and the dense cover was re-established. Where fire, fed by lightning, or where the hurricane made an opening in the timber, a young even-aged stand succeeded to the old, and grew in luxuriance.

There is every reason to think that this forest was unbroken over the entire region where soil, temperature and moisture conditions allowed the component species to make their best

growth. Into this heavily wooded area, containing vastly greater quantities of merchantable timber than today, the Indian came at a period anthropologically by no means remote, and the fires, kindled by him for the chase, or by accident, commenced their untrammeled sway. In a virgin forest of large-sized trees, even in so combustible a region as the Sierras, absolutely destructive conflagrations would not be the normal form of forest fire. But a continual procession of surface fires of more or less intensity do the deadly work of forest destruction with even greater efficacy.

Fig. 3. Open chaparral field, the result of continued fierce fires. Splendid view of Mt. Shasta in the distance.

At the present time the Sierra forests may be divided into three broad types in regard to their fire history.

1. *The denser timber.*—Fire being most destructive to the forest when it occurs periodically at short intervals, those areas where the visitation is not constant must be in the best condition. In a region so large as the Sierras and so mountainous, there must be large stretches which escaped damage for many years at a time. In this type of forest there is a heavy stand of timber, and it is either heavily stocked with mature trees, or if the old veterans are deteriorating, there is a large quantity of young growth filling the openings and taking their places. Many parts of this class of timber have almost escaped fire entirely, and show the normal type which should exist throughout the entire region on similar situations. Fig. 1 gives a fair specimen of the forest and its renewal under the old timber when it has a fair chance. Nearly all the valuable timberlands of the Sierras are in this type, which gives the state one of its greatest sources of wealth. The major part of this dense forest has suffered more or less heavily from fire, but it is generally in fair condition, and in itself, not being liable to severe fires, is not difficult to protect and manage.

2. *The open forest.*—Unfortunately for the economic value of the Sierras,

the dense forest is comparatively limited, and a great area is given over to an open stand of timber, growing in a ground cover of dense chaparral. This open forest has poor timber, both in quantity and quality. It is quite certain that this deterioration in value has been brought about by continued fire, and that without such repeated burning the forest would have been quite as dense and valuable as neighboring regions which suffered less severely. A continual procession of forest flow. The result is typical of great areas (Fig. 2). An open stand of over-mature and deteriorating trees above, and beneath a dense growth of chaparral interspersed with scattering poles and saplings which have escaped the repeated fire. For this and the succeeding class of its forests, California is indebted to the system of Indian burning.

3. *The chaparral field.*—In places where the fires have been fiercer and more regular, the picture is still more

Fig. 4. How an open chaparral field increases its bounds (Compare with Fig. 1)

surface fires of more or less intensity, running through the deep litter of the virgin forest burned out the younger growth, but left most of the larger trees standing. This burned ground is a natural seed bed, and at the next seed year the little trees would begin to appear. Another fire, however, would sweep most of them away, and the chaparral, previously kept in check by the dense cover, but quick to mature and a vigorous sprouter, begins to gain a dominating position in the dismal. Here the reproduction has failed entirely, and, the old trees gradually burned down or dying of old age, the ground is given over entirely to an impenetrable growth of chaparral. Figs. 3 and 4 picture a scene common enough through the mountains. There is not the slightest doubt that this land was once heavy forest and acre for acre should be as valuable a possession to the state as any of its natural wealth. Yet as such fields stand to-day, they are not only a nega-

tive quantity in the economic forest, but also an active factor of harm. They are the homes of fierce intermittant fires which sweep with fury through the oily manzinita and ceonothi, each time sallying further into the surrounding forest. Nearly always these open fields are surrounded by patches of dead timber or a sparse open forest receding before the continued attack. Fig. 5 shows this unequal struggle in action, and figure 4 shows the result in detail.

At least 21 per cent. of the potential forest area of the Sierras is given over to this entirely useless growth.

lem in the mountains. The old In- the forests of the entire state. Under these circumstances how can promiscous burning be of use?

THE FOREST FIRE PROBLEM.

Before lumbering commenced it was impossible for debris and litter to accumulate to a really alarming degree. If continual burning created the great chaparral fields, which are such a menace to the safety of the forests, before there was any great amount of debris in the forest, how much more dangerous must fire become after lumbering has commenced on a large

Fig. 5. Fire running from open chaparral field into green timber.

Summarizing the points given above:

As a result of continual fires set by Indians, the valuable forests of the state have been reduced to a relatively small area and great stretches of country given over either to a scanty low grade forest or to a worthless growth of chaparral.

This forest burning originated by the Indians has been kept in action by the carelessness of white settlers, so that the destruction is constantly continuing and is becoming a menace to

scale? In the train of every logging operation follows a wide area of heavy slash generally mixed with chaparral and so inflammable that fire sweeps through it with uncontrollable fury. Luckily, these areas are not yet of great extent, or continuous for a long distance, so that the danger lies not so much in the present as in the future. As logging goes on, and the lumbered areas grow greater, the menace from fire becomes the most important probdian fires may have been bad for the forest from a silvicultural standpoint.

by gradually reducing the density and quality, but the modern slash fire threatens every industry in the region. Logging on a large scale has just begun in the California Sierras. In ten years the amount of cut-over land will be a large per cent. of the present merchantable forest. As the trees are large and heavy crowned, the slash is very heavy, and if it is allowed to lie, as at present, a fire in such a logged area means not only the utter destruction of all reproduction on the land itself, but also the destruction of green timber about it.

Fig. 6. The same type of forest as shown in Fig. 2, where fire has been absolutely excluded for 20 years. Reproduction nearly perfect.

It is to the advantage of the State of California to see that a second forest replaces the one now being cut on such a large scale. This statement is so apparent that it is hardly worth making, save to emphasize the necessity for fire protection. Only in intelligent fire regulation is it possible to keep the forest in existence, and work to that end is the duty of every Californian. This may be brought about by a universal sentiment against fires and by the adoption of methods absolutely in accordance with the true state of affairs.

1. *Fire sentiment.*—The State of California has an excellent fire law recently passed by the state legislature. If every citizen makes it his duty to live to the letter of this law, and comply with its demands the greatest step toward the solution of the problem will be made. At present the idea is far too prevalent that fires are a necessary evil, and the problem of combatting them too insurmountable to be worth attempting. This is most assuredly not the case. All fires have small beginnings and prompt attention will reduce the number of disastrous burns an appreciable extent. Hearty and general coöperation with the fire officers and universal care in the fire season will make laws a success which otherwise will remain a dead letter.

2. *Methods of fire regulation and control.*—One of the greatest objections to the plan of fire protection by

burning the forest floor is the fact that it does not consider the many phases of the question but attempts to force one solution on several problems. There are at least three distinct variations in the question. (a) The protection of virgin timber, (b) the protection of old logged land, and (c) the protection of land as it is logged from year to year.

(a) *The Protection of Virgin Timber.*—It is to the advantage of all the cover of the present trees, and in a forest successfully protected from fire there should be plenty of young growth to take the place of old trees when they are removed. (Fig. 1.) In the open type of forest, fire protection is still more important. This type has been potentially lowered by repeated burning, but there is no doubt that a cessation of fire will result in a successful reproduction even in the midst of chaparral. This is very bril-

Fig. 7. Logged yellow pine with young growth left standing. Fire protection absolutely necessary

to see that lands which have not been logged are rigorously protected from fire. Apart from destroying young growth, continual fires burn out the bases of the old timber and lessen the value of saw logs. In some places the average damage from this cause rises to as much as ten per cent. of the value of the trees affected. This is serious enough, but even greater is the damage to young growth. Reproduction is always more certain under

liantly shown in the neighborhood of Placerville, Eldorado county. About fifty years ago the forest was very open, and the ground cover largely chaparral. In the sixties a considerable part of the country was taken over by ranches in such a manner that many good-sized areas of this open forest were quite inclosed by them. In these places there was no fire, and as a consequence a complete reproduction has occurred. (Fig. 6.)

In these dense thickets one may still find the roots of manzanita and ceonothi and see the scare of old fires on the seed trees. There could not be a better example of the results following an exclusion of fire.

The best method to bring about such an end is a systematic fire patrol and a system of telephone stations for reporting fires and calling assistance. Fire in this type is not difficult to check, especially if it is taken early. The Diamond Match Company has instituted such a system and finds that it bears excellent results at a reasonable cost.

(b) *The Protection of Old Logged Land.*—Although this area is not large in comparison to the total forest it is nevertheless of sufficient importance to justify separate discussion. Strange to say only a limited part of these logged lands have been burned, but where this has occurred the destruction of young growth has been total and the tracts are reverting to the hopeless class of the chaparral field. On the unburned land of this type there is almost always good reproduction and in many places it is quite remarkable. In almost every instance, however, the young growth is heavily interspersed with chaparral and debris. Fig. 7 shows a good example of such land. With adequate fire protection there is no doubt of this becoming an excellent young forest in which the chaparral will be almost wholly excluded. (Fig. 9.) At present it is peculiarly liable to conflagration and the mixture of slash and chaparral is a certain agent of destruction. Fig. 8 shows the lumbered land through which fire has run. Every seed tree and sapling has been destroyed and there is no future for the tract but reversion to chaparral. In the case of the land shown in Fig. 8, the fire not only destroyed the future of the logged land, but gained such impetus that it ran into neighboring green timber and destroyed a large

Fig. 8. The same forest as Fig. 7 after fire; the destruction is total.

area. There is, therefore, a two-fold object in the regulation of fire on old logged lands.

As the slash is mixed with valuable young seedlings which have grown through it, general burning is not possible, but protection may be best brought about by a dual system of fire lines and fire patrol. The fire lines should be laid out at a proportion of about one mile per section, and made to take advantage of all favorable situations. They are not fire lines in the strictest sense of the word, but merely strips three or four hundred feet wide along which all stubs have been removed and all debris burned as clean as possible. They are not cut clean of green brush, but are intended merely as places where a back fire can be set without danger of its running in the wrong direction.

Such lines should not cost on the average over twelve or fifteen dollars per mile, and, combined with a patrol should give efficient protection. This system is being worked out for the McCloud River Lumber Company, and is estimated not to cost over three cents per acre for the area protected.

(c) *The Protection of Land as it is Logged.*—It is to the advantage of all to see that the area of dangerous logged land shall not be extended. To this end the slash must be burned each season after logging. This burning, however, must be carried on with regard to the young growth left standing. In several parts of the Sierras attempts have been made at slash burning, all of which resulted in the utter destruction of the forest for years to come. Experiments at McCloud last year showed that by a little more careful falling and swamping, the tops and limbs may be grouped in such a way that most of the debris may be burned without doing great damage to remaining poles and saplings. A very small extra expense in

Fig. 9. Chaparral conquered by yellow pine which originally grew under conditions shown in Fig. 1. Fire danger slight.

swamping and burning will save large quantities of small timber which will have considerable value in a few years. At McCloud, it is estimated that the logged lands will have on an average of 8,000 feet B. M. per acre in forty years, if they are protected from any fire except the careful burning which removed the slash. Such burning is quite different from that upheld by the advocates of the Indian method.

In conclusion it may be said that in all parts of the Sierras, where forest growth is economically worth encouraging, the valuable species tend to supplant the chaparral. After the young trees have passed a certain age they tend to supplant the underbrush, and are less likely to a great burn than is the chaparral. (Fig. 9.) As the chaparral in extended acreas is the result of fire and as it is continually liable to fierce conflagration, it is the correct policy to make every attempt to reduce it by favoring the growth of commercial species. This end can only be obtained by the strictest and most intelligent regulation of fire and not by reckless burning.

WATER AND FOREST ASSOCIATION

An Organization of Public Spirited Citizens That Has Done Much for the Higher Development of California's Resources

BY

T. C. FRIEDLANDER
Secretary, Water and Forest Association

CALIFORNIA to-day leads all states in the work that is being done to develop the irrigation of its lands. Under the United States Reclamation Act work is under way to place 100,000 acres under ditch from the water to be derived from the Colorado River. Another project under the Reclamation Act contemplates the irrigating of 236,000 acres of land situated partly in California and partly in Oregon. The greatest development, however, taking place and in contemplation, is in what is known as the great central valley of California, comprising the Sacramento and San Joaquin valleys. Southern California, owing to the absolute necessity of the situation, has hitherto made the greatest progress in irrigating land under advanced methods, and the use of water as practiced to-day in that section stands as an object lesson to all the world of what can be done in this direction.

Since about 1885 up to 1900, but little development had been made in the great central valley of California in the placing of water upon the land. What was known as the Wright Act, which enabled the formation of districts under a mutual plan for the purpose of acquiring a water supply and distributing the water to the lands of the district, had been tried and disaster had ensued in many instances. In the Wright Act there were two fundamental defects which caused its failure. The first was a clause enabling a district to be formed by a vote of all inhabitants of the district and not (as should have been the case) by a vote of the acreage. Districts were formed in which one-half of the acreage objected to the formation of the district, whereas the votes secured in the towns and villages within its borders were sufficient to override the wish of the land owners. A second cause of disaster was the operation of the clause

providing for the administration of the district, and frequently the men in control had neither the ability nor the training to allow them to successfully handle large undertakings.

The new era of irrigation development in the great central valley of California practically dates from the formation of the Water and Forest Association, which was organized in 1899. It was apparent to those having an interest in the matter that there was a want of data upon which to build, and the first act of the Association was the raising of the sum of $12,000 to provide for what was considered the necessary preliminary investigations. These investigations were conducted by the Hydrographic Branch of the U. S. Geological Survey, to ascertain the flow of water in the streams, the available and economical situations for reservoir sites, and like data. Investigations were also conducted by the Irrigation Investigation Branch of the U. S. Department of Agriculture, to ascertain the duty of water and kindred subjects. The

Hon. JOHN G. NORTH
President of the California Water and Forest Association

United States government duplicated dollar for dollar the amount subscribed through the Water and Forest Association. The reports of the first year's work by these departments attracted universal attention and met with hearty approval. It was then the opinion of the Association that the state should continue this coöperative work. A bill was introduced into the legislature of the state of California, and at the session held in January and February, 1901, passed both houses, making appropriations for this purpose; but, unfortunately, the bill was vetoed by the then governor of the state. The Water and Forest Association felt that the irrigation development of the state was but arrested for a while and laid its plans to secure in the future from the state sufficient money to again inaugurate the work.

For two years a campaign of education was carried on, and as a result the legislature of the state of California, in 1903, passed a bill appropriating the sum of $60,000 to be expended for coöperative work, as follows: Topographic maps, $20,000; surveying reservoir sites and canal locations, $15,000; forestry work, $15,000; best method of distributing and using water, $10,000, with the understanding that the United States government would duplicate, dollar for dollar, the amounts appropriated by the state. The United States government not only did this, but spent more money than did the state. The result of the investigations conducted during the years 1903 and 1904 were so satisfactory that the legislature of the state of California in 1905 made an appropriation for the next two years for the same purposes in the following amounts: Topographic maps, $30,000; gaging streams, surveying reservoir sites, determining underground waters, $20,000; investigating economic quality and purity of water, $1,000; forestry, $10,000; best methods of using and distributing water, $15,000. These appropriations were contingent upon the expenditure of an equal amount by the United States departments that were to make the investigations. This shows a net increase over the appropriations of the preceding years of $16,000.

During the past three years there has been a marked increase in the irrigation development in the great central valley of California. Two districts alone in the San Joaquin Valley —the Modesto and Turlock Districts —comprise about 250,000 acres of land susceptible of irrigation, with perfect water rights and good supply of water. In the Sacramento Valley other projects have been practically completed that will enable the irrigation of a large acreage.

The handling of the water supply and the irrigating of the lands of the Sacramento Valley present such great possibilities that the attention of the officials of the U. S. Reclamation Service have been attracted thereto, and preliminary investigations are being conducted whereby this service may in the future undertake the work of placing under ditch 2,000,000 acres of as fertile land as can be found anywhere in the world. The investigations which are being conducted in the Sacramento Valley are along broad lines, which include a study of the forest covering of the mountainous portion of the entire basin, the exploration for survey of all reservoir sites and the establishment of gaging stations which will determine the available water supply for each of these sites, and the mapping in five-foot contours of the valley lands.

As the result of the coöperation by the state with the U. S. Departments, the Geological Survey is doing more investigation work in the state of California than in any other one state, and the same can be said of the work of the Department of Agriculture, through its Office of Experiment Stations.

The Water and Forest Association felt that no plan for irrigation development would be complete unless the natural reservoirs, consisting of the

slopes around the headwaters of the streams to be tapped, were properly protected. For that reason it devoted itself to the question of forestry and urged that the forest reserves of the state of California be materially increased. Many obstacles were encountered; in the Land Office in Washington itself and also in educating the people of the state of California to the necessities of the case. The work of the Water and Forest Association finally resulted in the withdrawal by the President of the United States in the year 1903 of all government land on the headwaters of all streams flowing into the Sacramento Valley. This meant a withdrawal of approximately 10,000,000 acres. Large quantities of this land have since been surveyed and such portions as were found unfit to be placed in a forest reserve were returned to the public domain. As fast as the surveys could be completed forest reserves have been made, and the next two years will see permanent forest reserves covering the watersheds of the streams in question. That the Bureau of Forestry has been enabled to accomplish so much in the State of California is directly traceable to the coöperation by the State, as evidenced in the appropriations made by the past two legislatures.

In connection with forestry matters the question of fire protection has received the attention of the Water and Forestry Association. At its instigation the U. S. Bureau of Forestry conducted investigations which enabled them to prepare a bill providing fire protection in the state of California. This bill in an amended form was passed at the last session of the legislature of the state of California and received the approval of Governor Pardee. The legislature also passed acts enabling the different counties to take legal measures for fire protection, so that to-day California has, in the opinion of experts, as good laws on fire protection for its forests as exists in any other state in the Union. While the machinery is there, the laws have not been yet put wholly in force. This necessarily takes time; but in the hands of the energetic governor of the state of California another year should see the whole system in perfect working order.

THE IRRIGATION INVESTIGATIONS IN CALIFORNIA OF THE OFFICE OF EXPERIMENT STATIONS

BY

ELWOOD MEAD
Chief of Irrigation and Drainage Investigations, U. S. Department of Agriculture

THE attractions of country life in California will in time make it the home of a dense rural population. The seasons are marvelously adjusted to the farmer's needs. Rain falls in the winter when it is needed and is withheld in the harvest season when it would be an injury. The soil is remarkably productive and there few, if any, countries in the world where so wide a variety of productions can be found on the same acre of land. The opportunities to enjoy life in the open, afforded by the mild and agreeable climate, makes the country attractive to others than farmers. The number of men of means, able to enjoy the best there is in life regardless of its cost, who are going to California to do this is every year increasing and

these men, as a rule, seek homes in the country. Hence, home-making in the country in California is being extended through two influences: the farmer and fruit grower who must make it pay, and the wealthy men of the cities to whom profit is a secondary consideration. With both classes, the expenditures on land in order to bring it to the highest state of cultivation, the beautifying of homes, and the land values themselves, are less dependent on profits in California than in any other part of the United States. This at present is shown more clearly in southern California than in the northern part of the state, but there is so little difference in the climatic advantages of the northern and southern parts of the state that in time the same influences will operate everywhere.

California now leads all the states in the extent of its irrigated area, in the value of irrigated land, and in the prices paid for water. It is a state where a large percentage of the new settlers are from the East and know nothing about irrigation methods. A knowledge of how to distribute water with the least waste, a knowledge of how to prepare land for irrigation, of how to apply water to secure the best results, has, therefore, in that state exceptional practical importance, and this fact has shaped the irrigation work of the Office of Experiment Stations in that State.

In southern California the water supply is limited and water rates are high. Every saving in the quantity of water used on an acre of land has a direct influence on the farmer's and fruit grower's profits. The cost of water at Ontario is about $10 an acre under the duty now obtained, and the capitalized value of a cubic foot of water per second, based on an interest rate of 5 per cent, is not far from $100,000. Hence, every additional acre which a given quantity of water will serve not only adds to the productive territory but tends to lighten in a marked degree the farmer's expenses.

This office is making a study in different districts of California of the method of applying water to crops best suited to their conditions. In the citrus orchards of Riverside, the soil is moistened through deep furrows and kept so by continuous cultivation. The furrow method is not at all suited to the soil conditions of much of the Imperial country farther south. There, copious and complete flooding gives the best result. In the northern part of the state, alfalfa can be irrigated most economically by means of checks, but checks are not well suited to rotation of crops. In view of the great future of this region, too much thought cannot be given to the working out of the kind of agriculture best suited to each section, and the adjustment to that agriculture of the irrigation methods suited to its crops and soil. The latter is part of the work of this office.

The greater part of the water used to irrigate orchards in southern California is pumped from wells. In the Pomona district, where pumping is being studied this season, there are about 145 pumping plants in an area of 300 square miles. Many of these raise water to heights of from 70 to 100 feet and the cost of performing this service represents a large part of the annual expense of raising crops.

There are many questions connected with the pumping of water for irrigation which farmers wish to have answered. The kind of motive power, the kind of pump, whether to have an individual plant or central stations from which the irrigators of a considerable area will be supplied, are examples which could be multiplied till the list became tiresome. The answers to these questions are affected by a great many conditions. The availability and cost of fuel, the character of the water supply, and the inclination or ability of communities to work together instead of maintaining the individualism which characterizes agriculture in regions of ample rain-

fall, are among the factors which must be taken into account.

Some of the conditions disclosed by these investigations bring out clearly how far agriculture has advanced from the time when men threshed grain with a frail and depended for travel on the slow-moving horse and cart. The irrigators of California have to be more than irrigators. They are dealing with questions that involve an expert knowledge of mechanics, of electricity, and of social and economic relations wholly outside the practical interests of the cultivator who farms where the rainfall is ample. Men's capacity is determined by what they attempt and achieve and it is not at all surprising that the irrigation communities that are having to deal with these broad problems show a general intelligence and civic capacity far above the average.

One example will be given of the kind of mechanical problems irrigation requires the farmers to solve. Eight miles north of Ontario is an electric power station, chiefly used to pump water for irrigation. The power is brought to the colony by transmission lines under 10,000 volts pressure. It pumps water from wells in the debris at the foot of the San Gabriel Mountains. This debris catches the water which comes down from the mountains and holds it practically in a covered reservoir. There are eight wells reaching down into this underground storage basin. A description of one will apply to all. The power which lifts water from this well is carried under a 2,200-volt pressure which runs a 50 horse-power horizontal induction motor capable of working continuously at a 60 horse-power output. It runs a vertical centrifugal pump placed at the bottom of a timbered shaft 140 feet deep, which is fed from a 12-inch tube well sunk 460 feet.

The farmers who depend on these and other wells not only have the settlement of the types and kinds of power which they shall select and which they can afford to employ, but they have to consider their relation to the ownership and stability of this underground water supply. The extension of pumping has caused a progressive lowering of the water plane of this region. In some localities the water level has fallen steadily at the rate of 10 feet per year. The water which fills the Gage Canal at Riverside was originally furnished almost entirely by flowing artesian wells. Gravity filled the canal. Now the lowering of the water plane requires 30 cubic feet per second to be pumped and has raised the cost of irrigation per acre from $2 to $7.66.

The progressive lowering of the water plane, partly due, no doubt, to a succession of dry seasons, has made the question of rights to underground waters almost as important as rights to surface water and has brought up a new class of legal and economic questions connected with water rights. One of the duties of this office, as defined by Congress, is to investigate and report upon the laws affecting irrigation and upon institutions relating to irrigation. California is one of the most interesting and fruitful fields for these studies. At present, however, the chief purpose of the work is to devise improvements to lessen losses from seepage and evaporation so as to postpone controversies over rights. This can be best done by lessening the quantity of water required for each acre irrigated, and this is the problem to which the office is addressing itself particularly during the present season.

Irrigation and drainage are two parts of a single problem. Drainage always has to supplement irrigation where seepage water or excess of alkali makes an accumulation of soil water a menace to continued productiveness. Measurements of the rise of soil water, measurements of seepage losses, and surveys of areas requiring drainage, are being carried on in various parts of California where the reclamation of swamped and alkalied lands is now, or will in the future be, an important productive factor.

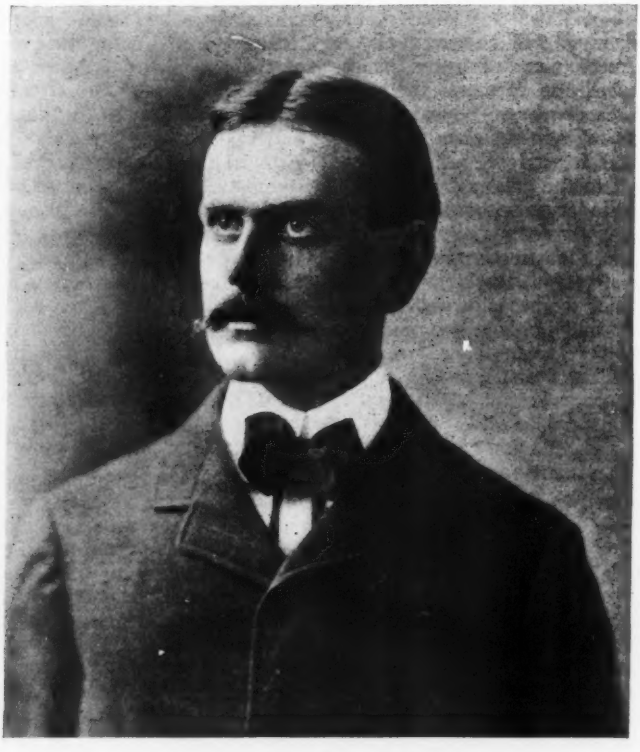
CALIFORNIA'S FOREST POLICY

BY

E. T. ALLEN
State Forester

THE immense area and diversity of the California forests and the large industries dependent upon them; the indispensability of irrigation, and therefore of forest protection, to agriculture; and the prevalence of forest fires and destructive lumbering methods, combine to make forest preservation in California not only of vital importance, but a problem of unusual difficulty. In a territory so large, and with such variations of altitude and climate, conditions differ perplexingly, and many important interests are hard to reconcile.

The necessity of some action has long been recognized. Forestry agitation began with the settlement of the state, and over 20 years ago a Board of Forestry was created by the legislature, with fairly adequate provision for its work. Some valuable results ensued, but question of the thorough utility of the organization



MR. EDWARD T. ALLEN
State Forester of California

led to its abandonment after eight years of existence.

For ten years following, progress was slow. Interest in the subject continued to increase; the more rapidly as irrigation developed, destruction increased, and the mountains became the resort of immense numbers of health and pleasure seekers; but there was lack of practical organization. Appeals were made by clubs and individuals and several laws were on the statute books, but there was little provision for their enforcement.

These conditions prevailed until the present state administration came into power, when Governor Pardee, a man of unusual public spirit and foresight, became actively interested, and an arrangement was made for a study of the problem by the Bureau of Forestry, the expense of which was borne jointly by the state and the Department of Agriculture. Besides the accumulation of much valuable scientific and practical information concerning forest conditions, this resulted in the passage by the last legislature of a bill creating a Board of Forestry, and providing for a state forester and two assistants. This act also contains several unusually well drawn sections for the prevention of fire, a notable one authorizing state forest officers to draft citizens for fire fighting without compensation and fixing a severe penalty for refusal.

Since this act has but just gone into effect, and organization thereunder has hardly begun, it is too early to record results. The policy, however, will be to make fire protection the important feature at first. Wardens will be appointed as fast as possible, and every effort made, by practicable demonstrations of fire-lines and patrol in selected localities, and by giving wide publicity to the laws, to arouse public opinion to a fuller realization of both the possibility and necessity of fire prevention. Enforcement of the fire laws will be strict, but with allowance, when necessary, for the local conditions and methods which often make well-meant but too sudden and drastic reforms unproductive of good. The development of planting and technical methods of forest management will follow, but will be considered secondary in importance until better assurance of fire protection warrants the expense they may involve.

FIELD WORK IN IRRIGATION

Work of the Office of Experiment Stations in California in 1905

BY

SAMUEL FORTIER
Irrigation Engineer in charge Pacific District

ELWOOD MEAD, in addressing the International Engineering Congress at St. Louis in 1904, remarked that "irrigation is a many-sided subject." Those of us who have had to do with the different branches of this subject in western America during the past twenty years realize the truth of this statement. In laying the foundation of so vast an industry, the builders of a quarter of a century ago had but a crude idea of what the super-structure would prove to be. In their minds irrigation consisted of diversion dams and ditches, and the task each community set about accomplishing was to divert water from a nearby stream on some uncultivated, but fertile, mesa. Brimful of hope, they imagined that with the completion of

this task their chief difficulties in the irrigation of their farms would be overcome.

The history of the vineyards of Fresno, the alfalfa fields of Modesto, or the citrus groves of Riverside in this state, reveals a truer conception of what irrigation really is. It is true that dams have to be built and canals excavated at great expense, and this engineering side of irrigation is destined to occupy a prominent place so long as the water resources of the West are undeveloped. But if our progress in the reclamation of arid lands is to be symmetrical we must build up from all sides. The man who is dependent on a part of the flow of a stream for water to mature his crops should be given a chance to find out how much belongs to him. The late snow as it melts on the elevated range rightfully belongs to the irrigators of the plains, but who will distribute to each his share? These obstacles to progress emphasize the necessity of giving some attention to the legal and administrative sides of irrigation which have to deal with the settlement of water rights and the equitable distribution of water. Finally, there is that wide and profitable field of investigation which is now attracting so much attention, viz: the proper use of water on cultivated fields which may be fittingly termed "the science of applied irrigation."

California, as regards irrigation, is still leading all other western commonwealths. In 1902 one-quarter of all the irrigated land in the United States was in this State, and it ranked first in the total number of irrigated farms and in the total construction cost of systems. In no other state of the Union is land so carefully cultivated, water so skillfully and economically applied, or the value of irrigated products so high, and in no other state is there so great an extent of fertile arable land for which the available water supply is so large.

Preparing an Orange Orchard for Irrigation by the Furrow Method

Notwithstanding this creditable showing, development in irrigation has not been symmetrical. Some branches of this dominant industry are

lagging behind. All the well-directed efforts of patriotic citizens to improve upon the legal and administrative features of our systems, while they cannot be said to have wholly failed, have not borne fruit. In this respect the state is so far behind the times that the moss is beginning to show green on our outer garments. But the people are still hopeful. In fact, Californians are always hopeful, and when sufficient progress is made in other directions their attention will again be directed in earnest to the determination of rights to the use of water and the establishment of an efficient system of administration.

It is gratifying to be able to state that in all other branches of irrigation the state is making rapid progress. The United States Geological Survey is obtaining valuable data in gaging the flow of streams, mapping irrigable areas, and locating and surveying reservoir sites. The engineers of the Reclamation Service have labored assiduously for the past three years in determining the feasible projects that may be built in future by the government. Apart from the work that is being done through the various agencies of the government, the people themselves are becoming enthusiastic over the beneficial results of irrigation and the important part which irrigated agriculture is destined to play in the future prosperity of this commonwealth.

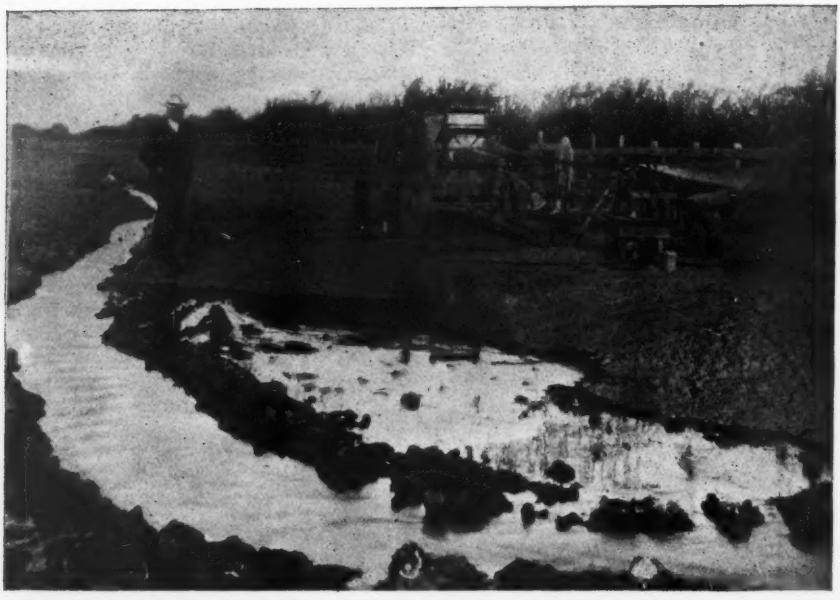
After noting this outline readers may understand more clearly the purpose of the irrigation and drainage investigations that are being carried on under the joint coöperation of the Office of Experiment Stations of the U. S. Department of Agriculture and the state of California. These investigations may be grouped under five different heads, each of which is briefly outlined in the following paragraphs.

IRRIGATION UNDER PUMPING PLANTS.

The owners of pumping plants in California are expending from one to two million dollars a year in raising water from wells for use on orchards, vineyards, and fields. In addition to this annual expenditure a much larger sum representing many million dollars has been invested in the equipment of these plants. This branch of irrigation, although the latest to be developed, is likely to prove in time one of the most important. In parts of this state the flow in the natural streams is practically all utilized and hereafter municipalities and farming communities must depend on underground supplies. In other parts the irrigable areas are so extensive, the sources of supply so far distant and the loss by percolation so great, that pumping becomes not only a cheap means of irrigation, but a necessity on account of drainage.

The operations in this branch are confined this year to the region around Pomona, in southern California, where there are about 145 pumping plants located within a radius of ten miles of Pomona. One part of the work consists of finding out what use is being made of the water which is raised from wells and the other part has to do with the mechanical tests of typical plants. The former includes a description of the irrigation conditions within the district, a determination of the duty of water under certain plants, a description of the methods used in applying it, and some knowledge of the yield and value of irrigated crops.

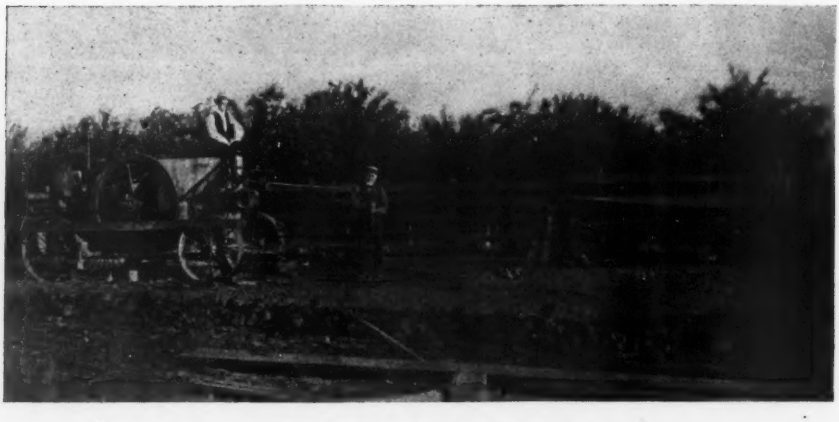
The latter includes a description of each plant tested and all the data pertaining to a complete mechanical test such as the discharge of the pump, the total lift, the power developed within the cylinder of the engines, the fuel consumed in a given time, the general arrangement of parts, the efficiency, as well as the good and bad features of the entire plant. Complete tests have already been made this season of 25 plants. It is hoped that the results of this line of investigation will tend to lessen the present cost of water, not only in remedying the mechanical defects of plants, but in a more economical use of water in the orchards.



Four-inch Centrifugal Pump driven by a twenty horse-power Gasoline Engine, near San Jose. Capacity 600 gallons per minute.

LOSS OF WATER BY EVAPORATION.

During the present season evaporation records are being taken at the following places in California: Calexico, in the Imperial Valley; Pomona and Riverside, in southern California; Tulare, in the San Joaquin Valley; Berkeley, to represent the Coast counties, and Chico, in the Sacramento Valley. Some of these stations are scantily equipped, but at other places there are water-jacketed galvanized iron tanks and apparatus for raising and weighing them, besides rain-



Another View of Same Pumping Plant

gages, thermometers, anemometers, etc.

Investigations in this line have been carried on for two years and have embraced the following experiments: To determine the rate and amount of evaporation from water surfaces such as from irrigation checks, canals, and reservoirs, and the influence exerted by such factors as temperature, wind, altitude, and humidity. In like manner an effort has been made to determine the evaporation from the surface of typical soils and to ascertain and compare the loss from this cause on soils that are irrigated in each one of the standard methods.

In an experiment which had for its objects the determination of the loss by evaporation from soils containing different amounts of moisture, the difference was so great that it was decided to take up the question of soil mulches of different depths varying from zero to 12 inches. Various crops have also been grown within tanks under field conditions to determine the actual quantity of water required by each for vigorous growth and in the same connection to ascertain, if possible, the transpiration of different plants and the relation between the amount of water evaporated from the foliage of plants and that lost by evaporation from the surface of the adjacent soil.

A little thought will convince anyone familiar with irrigation that these subjects which have never been considered by the cultivators of the old irrigated regions of Europe and Asia and which have but recently begun to attract the attention of western farmers lie at the very foundation of irrigation practice and until more accurate information is obtained concerning them the irrigator cannot be certain that he is watering his crop in the right way or at the right time.

THE IRRIGATION OF CITRUS ORCHARDS NEAR RIVERSIDE, CAL.

The successful production of oranges represents, it is believed, the highest type of the husbandman's art. As a corollary to this fact it may be stated that in no other part of the civilized world is there to be found more intelligent farmers than dwell amidst the orange groves of southern California. A high order of intelligence is required in order to succeed. In the first place suitable land on which oranges can be grown is high-priced, and water extremely scarce and valuable. In addition to these there is the cost of cultivation, irrigation, pruning, spraying, picking, packing, and marketing, all of which amount to a large sum per acre. The cost of production being so high there is need of skillful management and the closest kind of economy.

The main purpose of our investigations is to lessen the waste of water applied to citrus orchards and thus reduce the annual cost of the water bill. In order to accomplish this purpose it was necessary first to study in a general way the growth and root development of citrus trees, the depth and character of the soil, frequency of irrigation, quantity applied at each watering, mode of cultivation, and the like. In addition to these, a comparison is being made between the effects of shallow and deep furrows, and the rate of percolation from each. By means of borings and the taking of soil samples at different depths some knowledge is obtained of the distribution of water in the soil and the probable amount lost by evaporation from the surface. In the end, we hope to be able to give a partial answer to the irrigator's question, "what becomes of the water which is spread over my orchard during an irrigation?"

STUDIES OF METHODS OF PREPARING LAND AND APPLYING WATER.

During the past two years the different ways of preparing land to receive water and the most common methods of applying it have been studied. The results of these studies have been something of a revelation in that it has shown that this branch constitutes in many cases the big half of the

total cost of irrigation. It has been found, for example, that in the San Joaquin and Sacramento Valleys communities which have expended $10 per acre in building dams and ditches have had to expend a like sum per acre in order to prepare their fields in such a manner as to be readily and cheaply irrigated. At least $15,000,000 have been expended by the farmers of California in preparing the surface of their fields for irrigation. It is no exaggeration to say that the same work might have been better done for less than one-half of this immense sum if men knew how to go about it. Of necessity, every owner or occupant of an irrigated farm has had to do more or less experimenting in order to succeed, and $100 spent in experimenting on each of the 35,000 farms soon runs up into the millions. Now the agents of the Office of Experiment Stations are fully convinced that in the reclamation of the millions of acres of fertile land which yet remain unwatered in this state much may be saved in both labor and money if farmers are given an opportunity to become familiar with the best methods and the best practice.

The results of the preliminary work done in this line in 1903 and in a part of 1904 are embodied in Bulletin 145 of the Office of Experiment Stations and since that time the work has been taken up more in detail in particular districts of the state. The investigations now being carried on under this head are confined to the Modesto and Turlock Irrigation districts. An effort is being made to determine by actual demonstration to what extent grain can be profitably irrigated in these districts as well as the best methods to adopt in the irrigation of grain and alfalfa.

ECONOMY OF PERMANENT STRUCTURES IN THE IRRIGATION SYSTEMS OF CALIFORNIA.

The officers of irrigation enterprises have used mostly wood in building their structures in the past. In this custom they have but imitated the example set by the management of railways. But the pile and trestle bridges of railway companies are being rapidly superseded by steel and masonry, and it is believed that the time has now come when more permanent structures are needed in irrigation works.

The purpose of our study is to show by concrete examples the economy of using concrete and steel in place of wood and to compare the first cost, general efficiency and durability of such structures, as headgates, flumes, inverted syphons, drops, etc., when built (a) of wood, (b) of steel, and (c) of a combination of concrete and steel.

THE INFLUENCE OF PRIVATE TIMBERLAND OWNERSHIP ON THE FOREST POLICY OF CALIFORNIA

BY

E. A. STERLING

Assistant Forester, U. S. Forest Service

IN CALIFORNIA the high value of water for irrigating purposes, the presence of large natural forest reserves, and the general sentiment which favors and encourages forest preservation, combine to give opportunity for the application there of profitable and highly effective forest methods. The influence which is most powerful in preventing the utilization

of the forest resources of that state in a manner looking toward their continued productive and protective value is that exerted by the private timberland owner—the lumberman.

Of the total forested area in California, 13,418,136 acres are within the boundaries of the National forest reserves. Since these reserves are under careful management, fires in them are prevented as far as possible, and timber cutting restricted and regulated in order that the forest's productive capacity may not be destroyed, it would appear that Californians need not fear the denudation of their timberlands or the diminution of their supply of irrigating waters.

Yet the facts of the case are that much of the finest timber lies outside of the reserves and that the best stands on the important drainage basins

Private Timberland in the Sierra Forest Reserve

within the reserves are in the hands of individuals or corporations. Most of these private owners are not as yet inclined to apply even the fundamental principles of forestry, but cut their timber by the destructive methods which under present economic conditions give the highest returns regardless of the condition in which the cut-over land is left, or of the effect on future growth or water conservation. The results are bound to have a most potent influence on the agricultural development of the state, through the increased difficulty of regulating floods and of securing the water needed for irrigation and power.

Private land within the San Bernardino Forest Reserve, lumbered and burned in 1903

California is with good reason considered one of the most advanced states in forestry matters. The people are progressive, appreciative of their forest resources and have not neglected opportunities to procure advice and assistance which should insure the highest use of the water and wood. This is shown by their liberal contribution for cooperative work with the Federal government during the past two years. They have, too, on their statute books a recently enacted forest code, which provides for the management and protection of the forests within the state.

The successful application of this forest law depends largely on the attitude lumbermen take toward it. Without forests of its own and with such large areas in the hands of the Federal government, obviously the only remaining field of action to the state is on the forest lands of the private owner. It is possible to render him cooperative assistance of the utmost value, and if it is accepted highly beneficial results will accrue to the State at large. On the other hand, if this assistance is not welcomed, and if the disposition shown by the Legislature at its last session, to oppose legislation helpful to the forest owner, grows, the private timberland owner may be the cause of changing the

whole forest policy of the State. This change will not be for the better, but will undermine a carefully-prepared policy which promises to place California to the fore of all other states in the matters of applied forest legislation.

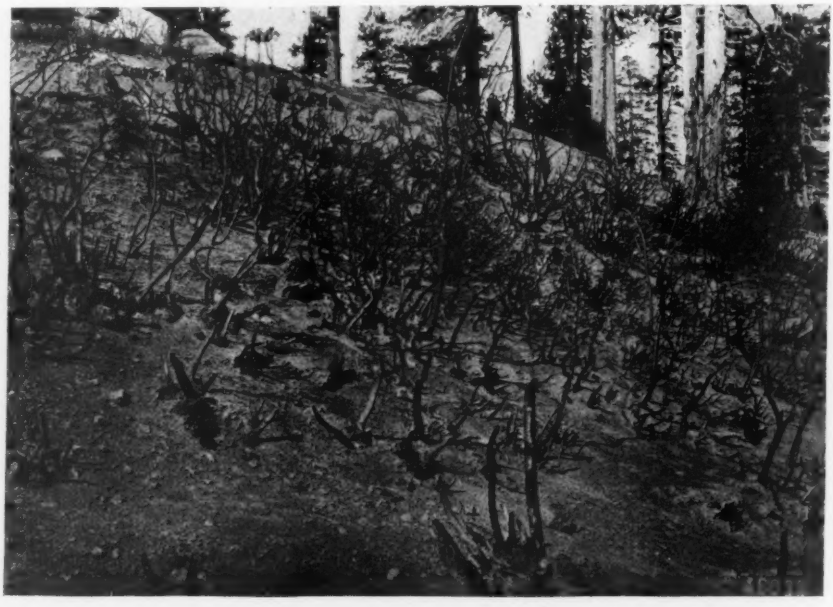
If the lumberman is not reached, and state and Federal forestry is applied in only the National reserves and state parks, the tendency of the people will be to overlook this work and say that the expected results have not been forthcoming. The reserve administration would persist despite such a sentiment, but it would take even less than this to turn the State Legislature against forestry, and secure the repeal of the forest law. It is of the utmost importance then that every effort be made through cooperation and education, to secure the most complete utilization without destruction of the private forest lands within the state.

Demonstrations of the results bound to follow if present logging methods continue unmodified are not wanting. The American River to-day finds source in a well-forested region in the central Sierra, and maintains a full, well-regulated flow throughout the year. Practically its entire drainage basin is owned by two lumber companies, one of which is cutting at the rate of 50,000,000 board feet per year. The changes in the condition of the watersheds of the American River which these operations are rapidly bringing about cannot fail to have a most marked influence on the character of the streamflow. The flood situation in the Sacramento Valley is becoming more serious yearly, and thousands of acres of valuable wheat land are lost through inundation or gullied beyond repair. A plan costing into the millions is projected for the control of these floodwaters. The Sacramento River is fed by numerous tributaries which flow from the forested slopes of the adjacent mountains. These timberlands are under rapid exploitation, and the retaining forest cover is removed from thousands of acres annually. This means that the speed of the runoff and the amount of debris and silt carried by the streams will increase indefinitely. Consequently, dredging the main river, straightening the channel, and constructing dikes in the valley, will not touch the root of the evil; in order to be of permanent value all such work must look to an increasing volume of floodwater in keeping with the disturbance of the watershed cover by logging operations.

Another example is found in the San Bernardino region in southern California, where every inch of water is carefully utilized and future agricultural expansion is wholly dependent on the development of an additional water supply. The entire mountain range adjacent to the rich fruit lands of the valley is within the San Bernardino Forest Reserve. Most of this reserve, however, is covered with chaparral, and the small stands of timber—on the only true forest land in the region—is owned by lumbermen, who are cutting it rapidly. Fortunately, most of this timber occurs on the drainage basins of streams which flow into the Mohave Desert and are lost; yet the reduction of this land to chaparral or barrenness will have its effect on the water supply, and especially on a new irrigating reservoir which is under construction.

The general effects of the present methods of logging private land in California are several. The tendency is everywhere strong for cut-over land to revert to chaparral, and repeated fires continually render this condition worse by killing the reproduction and ultimately the seed-trees. Through its sprouting powers the chaparral is thus extended over large areas which cannot be reclaimed by natural processes as long as existing conditions prevail. In California, as elsewhere, fire is the greatest hindrance to applied forestry. The floor of the virgin forest burns over readily, but it is not until the land is logged that the fires attain their

maximum violence. Private timberland owners assume a hopeless attitude toward the fire question, rarely making systematic effort to protect even their own property. The effect of the repeated fires in reducing the forest's productive capacity and destroying its water-conserving powers does not need elucidation here. The annual loss to the state from this source deserves the most serious thought. The water question is mightily influenced by the management of private timberlands, through the effect which the fires and chaparral which follow logging have on the water-retaining capacity of forested drainage basins. Whether or not the general climatic conditions are changed is an unsett'ed question, on which scientists usually take the negative and laymen the affirmative side.



Forest Land which has reverted to Chaparral, and the Chaparral in turn burned to an extent which destroys its value as a watershed cover

It must not be inferred that private owners of timberland in California are any different or any worse than those elsewhere, or that there is here the slightest intention of taking sides with the sentimental forest enthusiast who brands all lumbermen as vandals. Since California is on the upward wave of forestry progress it is unwise, however, to overlook the influence which the private owner exerts. His methods of management are natural and logical. He has to deal with a purely business proposition, which will continue as such. The hope of forestry is that it, too, is based on business principles which, with the changing economic conditions, can be successfully applied to lumbering operations. The application of the more fundamental principles of practical forestry on private timberlands in California will ward off the menace to the water, agricultural, and timber interests which threatens if present methods are continued.

Compared with other regions and other states the attitude of the Cali-

fornia lumbermen toward forestry is excellent. Many of the operators are from the lumber-producing districts of the South and East, and have seen the disastrous results of non-conservative logging. Moreover, they realize that unexploited timberlands are no longer easily obtainable and that their present holdings must be managed with a view to future continuous production if their business is to be perpetuated. The strong natural tendency of the California forests to reproduce themselves and the exceedingly high value of the several commercial species, strengthen the possibilities of conservative management, and slightly modified logging methods combined with reasonable fire protection will change the whole aspect of affairs.

Cooperation which will give the private timberland owners the assistance of State and Federal foresters is the need of the hour. This assistance in matters of fire protection and of management has already been furnished in several cases by the Bureau of Forestry, and the tendency is toward expansion in this direction. After the organization of the state forest system, active cooperation may be expected from the technical forest officers of the state. On the whole, the outlook is promising, and although the most serious results would follow a continuation of existing methods, there is almost absolute certainty that within the next decade all will be changed for the better. The systems of logging and of fire protection applied by the National government on the forest reserves will demonstrate the possibilities for profit in conservative forest management; while the growing scarcity and increased value of both major and minor forest products will make possible the better use of private timberlands, and the reforms introduced will insure a decided economic advantage to the owners of such conservatively-managed land.

This question of private timberland ownership and management in California is extremely important and should receive careful local study in each of its many phases. No attempt has been made here to more than briefly outline the more striking points, and indicate in a very general way the influence which the lumbermen exert on the forest policy of the state. To summarize, it may be said that if present methods remain unmodified the forest and water resources, which are two of California's greatest assets, will suffer irreparable injury, and the general policy which aims to secure the highest use of these resources will lose its force. On the other hand, if the practicability of forestry on private timberlands is fully demonstrated, there is no state where there is better opportunity for the development of an effective forest system, or where a greater variety of important commercial interests will be benefitted.

STUDIES OF CALIFORNIA GROUND WATERS

BY

W. C. MENDENHALL

Geologist, U. S. Geological Survey

THE U. S. Geological Survey has been engaged for nearly two years in a study of the underground water situation in Southern California. The work began in the region known as the Valley of Southern California. This is the irregular lowland south of the San Gabriel and San Bernardino mountains, in which the cities of Los Angeles, Pasadena, Pomona, Ontario, Redlands, Riverside, and Santa Ana are situated. Throughout this delightful area, water is worth more than in any other agricultural district in the Western Hemisphere, because of its limited quantity and the high values of the lands to which it can be applied. Two thousand dollars per miner's inch, a flow equivalent to about 13,000 gallons per day, is not regarded as an excessive valuation in parts of this area, and some of the citrus lands are bearing water charges at rates of from $10 to $30 per acre per year. Such taxes are possible only where the returns from the crops raised reach high figures, as they do in the best of the California citrus lands.

Irrigating waters are pumped to heights of 250 feet in a few cases in Southern California, and are in successful use despite this great lift. At one point in the San Joaquin Valley water is pumped to an elevation of 600 feet above its source and used in citrus irrigation. This is probably the highest lift in the United States of waters for agricultural uses. The fact that it is found to be feasible from the financial standpoint to install and operate the expensive machinery required for this purpose, is a sufficient commentary on the productiveness of the lands and the value of the crops which they yield.

In communities where such practices prevail it is needless to say that the value of water is fully appreciated and that the citizens are heartily interested in all studies which tend to throw definite light on the quantity and availability of the supplies. The best engineering talent has been busy for two decades, devising means whereby waste of water may be prevented, new sources utilized or old sources conserved. Reservoirs are being covered, unlined ditches cemented, open ditches converted into pipe lines, irrigation practice improved so that evaporation from the soil surface may be minimized, and temporary flood water dams built, to aid in recharging the subterranean basins. The influence of forests is realized and local chambers of commerce are making appropriations to aid in reforesting denuded slopes in the important drainage areas. At the same time the courts are restudying with great care all the principles upon which water rights are based. As a result, epoch-making decisions have been rendered whose object is to preserve and protect vested rights in underground waters, rights which seemed in jeopardy under the attempts to apply old riparian principles under conditions which were not anticipated in the place and at the time when they were enunciated.

It is in this spirit of care and thoroughness and exceptional intelligence, that the Southern California communities are grappling with their problems of water supply. It is not surprising therefore, that they have accomplished much with the rather limited quantity which is available for their use.

The minimum summer flow in the Southern California streams, and it is this minimum which controls irrigated acreage, is in round numbers 250 second feet. With high economy this would be sufficient to irrigate 80,000 or 90,000 acres. Actually, 225,000 acres are under irrigation. This result has been accomplished by the utilization of underground waters. These subterranean sources now furnish supplies for twice as much acreage as the surface waters. They have certain definite advantages over the surface supplies, in that their quantity is comparatively uniform throughout the year; while surface streams are lowest when the demand for water is greatest.

These waters which have become so important in Southern California, during the last decade especially are the object of especial investigations now under way. Their distribution has been pretty well determined by the developments already carried out, but their quantity and the limits of safe use are not known. A series of observations is now being made whose object is to determine whether these limits have been reached in any particular community. These measurements have been conducted for nearly a year and preliminary deductions may soon be reached from them. Meanwhile, reports are being issued in which the results of studies of underground conditions are given, artesian outlines and changes in artesian areas are mapped, depths to ground waters are shown, the results of determinations of alkalinity are given, and lists of wells, with their costs and yields, are tabulated. All of these accompany texts in which the sources of the ground waters are discussed and their quantitative dependence upon rainfall on the one hand and development on the other, are brought out. It is hoped that where a tendency exists to develop underground waters beyond the limits of safety, that tendency may be checked by a clear statement of the conditions.

In certain portions of the desert areas of Eastern and Southern California, underground waters are known to occur in some quantity. One of the most important of these areas is that centering about Indio, Coachella and Walters, in the northwestern end of the Colorado desert. Fifty years ago, when this desert, 287 feet below sea-level at its lowest point, was one of the most dreaded spots in the arid west, Prof. W. P. Blake predicted that artesian waters would be found beneath its surface. In 1888 the Southern Pacific Company secured a small artesian flow at Indio, and the prediction made 35 years before was fulfilled. Since 1900, when a method for sinking deep wells rapidly and cheaply was applied, developments in this desert valley have been rapid. Its unique climatic conditions, which favor prolific growth and the early maturity of many crops when water can be applied to the soil, have given it especial agricultural advantages which are being utilized by its pioneer settlers.

Its growth depends entirely upon the underground waters which are secured from about 350 wells. The majority of these are artesian, and with the waters which they yield 4,000 acres have already been brought under cultivation. Cantiloupes, watermelons, sweet potatoes, early table grapes and hay and grain crops are successfully grown, and the finer qualities of dates, and citrus fruits are being tried. The ground waters in this region, upon which its agricultural existence and continued growth depend, have been carefully studied by the Survey and a report upon them is now in course of preparation.

Down through the center of California stretches the great Valley of the Sacramento and San Joaquin Rivers. It is 400 miles long and from 10 to 50 in width, an empire in itself. From south to north and from east to west it presents a wide range in humidity from a rainfall of 8 inches annually to one of 40 inches. The variety of prob-

lems presented for the consideration of the hydraulic engineer is equally wide.

In the central part of the great valley, reclamation is a question of the protection of overflow lands and their drainage in part by pumps. One feature of this protection may be the construction of great reservoirs on the larger tributaries to hold back a part of the most destructive floods. The waters thus impounded may be beneficially utilized for irrigation on accessible arid lands about the borders of the valley. In other sections reclamation depends entirely upon the artificial application of water, either impounded in surface reservoirs or drawn from underground. In still other sections, irrigation must be combined with drainage and the washing out of alkalies. Great volumes of water flow down annually from the Sierras, but nature has distributed them inequitably. Some sections receive too much, others not enough. The task of the engineer is to correct this inequitable distribution.

The subterranean waters are not as yet extensively utilized in this great valley. Gravity waters are much more cheaply and easily applied, and development thus far has depended almost entirely upon them. But it is thought that underground waters exist in great quantity beneath extensive areas in the dryer sections, and that they are sufficiently near to the surface to be readily accessible to many communities which are not now using them.

A study of these waters as a possible source of supply for irrigation in the San Joaquin Valley is now under way by the Geological Survey. This investigation has just begun and conclusions cannot yet be drawn, but preliminary impressions are most favorable. Extensive utilization of these waters may lead to a radical change in agricultural conditions. At present, lands in the San Joaquin Valley are in very large holdings, but it is recognized that in order that irrigation may be a success, intensive cultivation of small units is an essential prerequisite.

The character of the work done and the nature of the conclusions reached by the Survey representatives in the San Joaquin Valley and in Southern California are essentially different, although the methods followed in the two areas are similar. South of the Tehachapi, the studies have been largely of the effects of intense development in a densely inhabited region. There the attempt is being made to determine just how far development of underground waters can go without jeopardizing the future supply. In the San Joaquin Valley, on the other hand, the Survey representatives are studying an as yet undeveloped resource. They expect to reach conclusions as to its possibilities when developed, and hope to make definite recommendations which will be of substantial value to the agricultural interests of this section of California.

THE FOREST RESERVES OF CALIFORNIA

BY

A. F. POTTER
Grazing Expert, U. S. Forest Reserve

AT present the State of California leads all others in the number of its forest reserves and the area of land included within their limits. The people of California were among the first to realize the importance of forest protection and have given their hearty support to all movements looking toward the improvement of forest conditions. All of the great industries,

agricultural, mining and grazing, are dependent upon a conservative use of the resources of the forest reserves, and there is no question before the people which is of more importance to their future welfare.

Up to June 10, 1905, there had been established within the state fourteen forest reserves containing a total area of approximately 14,250,000 acres; an acreage almost double that included in any other state or territory. There still remains withdrawn from entry a large area from which it is probable several additional reserves will be created, so that ultimately the National Forest Reserves of California will include about 16,000,000 acres of land.

The reserves differ greatly in the character of lands included within their limits, and in their importance to the different interests of the state. The first and most urgent demand for the creation of forest reserves was from Southern California where the future prosperity of almost the entire commonwealth depends upon the protection and proper use of the mountain lands which form the source of water supply needed for irrigation of the adjacent agricultural lands.

The San Bernardino, San Gabriel, San Jacinto, Trabuco Canyon, and Santa Barbara Forest Reserves are of greatest importance as conservors of the water supply, and of least importance for lumbering, grazing and mining. Only a small proportion of the area of these reserves is covered with forest which produces merchantable timber, and owing to the extreme necessity of using every means to preserve the existing forest, and to extend its area, the government has been very conservative in the sale of timber and granting of free use privileges. Only such timber as beyond any doubt could be spared without danger of injury to forest conditions has been allowed to be removed. In granting grazing privileges in these southern reserves, the greatest care has been exercised to prevent any possibility of injury by allowing to much stock or by the manner in which it is handled or distributed on the range. Only cattle and horses belonging to residents, either within or near the reserves, are allowed, and sheep are excluded entirely.

During the past two years exhaustive studies have been made of the brush covered areas within these reserves to determine the extent to which the presence of different varieties of brush or chaparral is due to the destruction of former forests by fire or other causes, the degree of protection which it furnishes to the water supply and its value in preventing erosion of the soil.

Extensive experiments have been made in tree planting on brush-covered areas, and much valuable information has been gained in regard to the adaptibility of the different species of conifers in reforesting the treeless areas.

These studies and experiments will be continued and the ultimate result, undoubtedly, will be to gain the thorough knowledge necessary to insure success in the future improvement of forest conditions.

The greatest menace to the safety of these southern reserves is fire, and the prevention of and protection against fire, has been the most difficult problem in their management. It is of vital importance that the great destruction from this cause be realized, and that campers, hunters, and stockmen, who enter the Reserves, should use every precaution to avoid any possibility of allowing a forest fire to start from their camp fires. If the people are careless in this regard, progress in the improvement of conditions will be slow, therefore every good citizen should give his hearty support to the forest officers, and do his part toward moulding a strong sentiment in favor of forest protection.

In the Sierra, Stanislus, and Lake Tahoe Forest Reserves, which cover the main body of the Sierra Nevada Range in the central part of the state, the lumbering and grazing interests

advance in importance. Although the protection of the source of water supply is not to be disregarded, the natural conditions are more favorable and the extreme vigilance necessary in the southern reserves can here be relaxed somewhat. Consequently, the mature timber can be more freely disposed of to the mining and other interests needing it, and the forage crop can be more closely harvested without danger to the reserves. Liberal allowance is made for grazing cattle and horses, and on the eastern slope of the Stanislaus Reserve, sheep grazing is allowed. The question of allowing sheep grazing on certain portions of the Sierra reserve, which are reported as best adapted for use by that class of stock, will be investigated during the year and all interests carefully considered before final action is taken. Trails have been established through both the Sierra and Stanislaus Reserves for driving bands of sheep across in moving between summer and winter pastures. Every effort will be made to encourage the stockman in a proper use of the forage and special inducements will be offered to those who willingly coöperate with the government in the protection and improvement of the reserves.

One of the greatest needs for the future development of the mining interests of the state, is cheaper power. This can best be secured by use of the water power furnished by the mountain streams in generating electrical power. The regular flow of water necessary for the success of this enterprise is best insured by preservation of the forest conditions on the head waters of the streams. The success of mining also depends largely upon the forest, because the miner must have an ample supply of timber for use in working his mine, he therefore has a vital interest in the preservation of the forest, and should be one of the strongest supporters of the reserves. In the future management of the reserves an effort will be made to meet the local needs and make improvements in the methods of transacting business, which should result in great benefit to the mining industry.

Since January 1, 1905, six new forest reserves have been created in the northern part of the state, as follows: The Modoc, Warner Mountains, Plumas, Trinity, Klamath, and Lassen Peak. These reserves were all examined carefully prior to their creation and the boundaries have been drawn so as to include only lands suited to forest reserve purposes.

In the Modoc and Warner Mountains Reserves, located in the extreme northeastern corner of the state, the principal object in their creation was the protection of the water supply needed to insure the continued prosperity of the adjoining settlements. Stock-raising is one of the most important industries in this section and liberal allowances have been made for grazing cattle, horses, and sheep. It will be the policy to allow a full utilization of the forage products of these reserves and to gradually adjust the number of stock allowed to the actual grazing capacity of the lands. With range protection a better grade of stock will be raised and in the long run forest reserve regulations will result in insuring a permanent improvement in range conditions, and increased prosperity to the resident stockmen.

The Plumas, Trinity, Klamath, and Lassen Peak reserves are all chiefly valuable for their extensive forest, and excellent stand of merchantable timber. In the Plumas Reserve, of its 579,520 acres, it is estimated that 80 per cent. is forest land with a stand of accessible merchantable timber averaging 7,450 feet board measure per acre. In addition to this, there is almost an equal amount of timber which at present is inaccessible, but will become available in the future when the demand is sufficient to warrant the building of roads for its transportation.

In the Trinity Reserve it is estimated that sixty-five per cent. of the

area has a stand of merchantable timber averaging from 5,000 to 50,000 feet per acre. At present this timber is remote from transporation and the only demand upon it is for the local supply of the mines and settlements in its vicinity.

The Klamath and Lassen Peak reserves both contain a very large proportion of forest land, but the stand of merchantable timber is lighter, and does not generally average more than 5,000 to 6,000 feet per acre, although there are limited areas which will produce over 50,000 feet per acre.

Only a very small proportion of either of these reserves has been cut over, and their protection and conservative use, therefore, means an assured annual crop of timber to supply the needs of the state in the development of its mining, agricultural, and commercial interests.

The live stock interests are of considerable importance on these four last mentioned reserves, and the proper utilization of the forage will be one of the important questions in their management. Owing to the fact that the season is now well advanced, the grazing regulations will not be enforced in the Trinity, Klamath, and Lassen Peak Reserves this year, but all stock which have been grazed regularly therein will be allowed to remain. Every effort will be made to assist the stockman in a satisfactory division of the range and in a better and more economic use of the forage.

The business men of the state have been aroused to the importance of protecting the forests, and public sentiment is now very strong in support of a conservative forest policy. This has been substantially demonstrated by the action of the state legislature, first in the passage of an act providing for a coöperative forest investigation by the Bureau of Forestry, and finally by the passage of a strong state forest law. It is the duty of the government to assist the people in bringing about the best possible use of all forest resources. The people, on the other hand, must continue to give their support and assistance in carrying out the work which has been so well begun, and must coöperate with the state and national forest officers in the enforcement of such regulations as are necessary to insure the best use and permanent value of the forests.

HOW THE COMMERCIAL ORGANIZATIONS OF CALIFORNIA COOPERATE WITH THE MOVEMENT FOR GOVERNMENT RECLAMATION.

BY

HAMILTON WRIGHT*

CALIFORNIA is vitally interested in the subject of irrigation. Water is the life blood of the state's agricultural development. The value of products of irrigated land in California is more than double that of any other state, though the actual irrigated area is estimated to be less than that of the state of Colorado. In certain sections of California, notably the southern part of the state, water is more valuable than probably anywhere else in the world. For these reasons the people of the whole state are eager to take advantage of the National Reclamation Act, and it is of interest to

* Mr. Wright accompanied the Congressional Irrigation Committees on a large part of their recent western tour.

note that there is such thorough organization and unanimity of sentiment in California that they are enabled to avail themselves of its privileges.

During the lifetime of the state a number of these properties were originally Mexican grants, whose owners were, apparently, unwilling to subdivide for the benefit of intending settlers. This condition, if not remedied, would disqualify some of the most

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Executive Officer of the California Promotion Committee, and President of the River Improvement and Drainage Association of California

unique agricultural condition has prevailed in California. Much of the best agricultural land is held in huge ranches, some of them embracing in the neighborhood of 100,000 acres in single holdings. By far the larger promising agricultural sections of California from taking advantage of the provisions of the Reclamation Act. As is generally known, the purpose of the government in constructing great storage and diversion dams and in build-

ing canals, laterals and headgates under the Reclamation Act, is to provide homes for the homeseekers. Consequently the farm unit is limited to 160 acres and in some instances to less than this amount according to the character of the land. Although the government contemplates irrigation projects for the benefit of homesteaders, and endeavors, as far as possible, to undertake works with the view of bringing water to available government lands, yet, in the event that individuals are willing to subdivide their lands and to sign a contract which will prevent land speculation, anticipating increased values through irrigation, irrigation works will be undertaken under the Reclamation Act even where the land is in private ownership. This is the case in the Salt River Valley, Arizona, where a dam capable of impounding enough water to irrigate 200,000 acres of land will be constructed. The settlers in that section have gone ahead and accomplished marvels. The development has exceeded the water supply, but they are willing to sub-divide; the government is coming to their aid.

The commercial organizations of California will make possible the work of the government under the Reclamation Act by effectually conducting the campaign for the sub-division of great tracts where irrigation works are under consideration. There are in California 152 Chambers of Commerce and other quasi-public improvement organizations of like character. They all work in harmony through the California Promotion Committee, the state central organization, which is the clearing house, as one might say, for the expression of united public sentiment for progress. The executive officer of the California Promotion Committee is Mr. Rufus P. Jennings, a prominent merchant of San Francisco, who has established business-like principles in the work of building up the state. Mr. Jennings is a constant, optimistic and cheerful worker for the state and the whole west. He has so systematized promotion effort in California as to make the sentiment of the commercial bodies of the state an irresistible force for progress. Already the California Promotion Committee has heard from more than 70 owners of huge tracts of land that they will sub-divide. Some of these properties are so vast that it would take a man half a day to ride across one of them, and their sub-divisions oftentimes occasions a considerable sacrifice on the part of the owners.

There are more commercial organizations in California than in any other state. They expend in their regular routine work all the way from $1,000 to $30,000 a year each. Those who support them obtain no direct benefits, but share results with the rest of the community. The organizations invite confidence and command respect. They have nothing to buy and nothing to sell. They crystallize public sentiment. Primarily their function is to advertise and induce immigration. The larger part of this work is performed through the California Promotion Committee, the local organizations devoting themselves more particularly to making ready for the settler and of caring for him when he arrives in California. In this immigration work the commercial bodies can be of the greatest assistance to the government which desires a progressive class of agriculturists to take up land under the reclamation projects. If the settlers succeed, and everyone conversant with conditions in the areas to be reclaimed is convinced that most of them will succeed, they will be enabled to return to the government the sum expended on the project in their territory as contemplated in the Reclamation Act. In the great Truckee-Carson project recently completed the government has finished the work (or at least enough is completed for demonstration), and it remains for the intelligent and industrious settler to do his part. When it is known that in a little over two years the California Promotion Committee has sent out

over 2,000,000 pieces of literature; had a correspondence of over 225,000 letters; published hundreds of articles in the press and sent out lecturers through the farming districts of the east, it is apparent how organizations of this kind can assist the government in selecting a desirable class of settlers.

A project of great importance to California is the reclamation of approximately 2,000,000 acres of land in the great Sacramento Valley. The climate conditions are far less extreme than those in the desert regions. Here the land is in huge holdings being mainly devoted to grain or grazing, but wherever irrigation has been practiced the results are remarkable. It is the largest and most comprehensive irrigation project which the government has under consideration. Water will be conserved by means of seven huge reservoirs and distributed over the valley, which is 250 miles long and from 20 to 60 miles in breadth. Here the problems of irrigation, reclamation, navigation and drainage are all closely connected; for, with the storage of waters, the crests of the spring floods which have for years broken the levees on the lower reaches of the Sacramento River and destroyed millions of dollars worth of property will be controlled. A movement fostered by the River Improvement and Drainage Association of California, is now under way to improve the navigation of the Sacramento River and reclaim 1,000,000 acres of swamp lands. The work calls for an expenditure of $24,000,000. Twice as much land will be reclaimed as in the case of Zuyder Zee project in Holland at less than one-fourth the cost. The recommendation of a commission of engineers consisting of Major H. B. Richardson, Major H. M. Chittenden and Mr. T. G. Dabney, calls for a uniform system of levees which shall confine the river and cause it to scour and, consequently, deepen its channel. The extension of the levees with connecting dikes in the overflowed lands will enable these lands to be reclaimed. The cost of this work will be born equally by the state of California, the Federal government, and the land owners. The improvement of the Sacramento River and the reclamation of the swamp lands is of course in no way connected with the irrigation project for the Sacramento Valley under the Reclamation Act. The government's part in the river improvement will be carried on by the War Department while the irrigation project comes, of course, under the Department of the Interior. But in both projects the commercial organizations are lending great aid to the movement. The whole state of California is behind the river improvement project, and without the united sentiment which was brought out at a meeting of representatives of all commercial organizations of the state, the united work would never have been undertaken.

The United States Senate and House Committee on Irrigation recently completed an extensive trip through the west. The journey was made for the purpose of visiting locations where irrigation works have been begun or are planned under the Reclamation Act, and incidentally of gathering first-hand information relative to irrigation in general. The journey was a distinctly strenuous one and the members of the visiting committees put in long and earnest hours (at their own expense). Though the visit was not official, much will result, as it was an educational campaign on irrigation, not only for the members of the Senate and House Committees, but for the residents of the regions visited.

The intense and general interest in the subject of national irrigation was most enthusiastically demonstrated everywhere. The citizens turned out in great numbers to greet the visiting legislators. The California itinerary lasted eight days, beginning at Yuma on the morning of June 8 and terminating at Sacramento on the night of June 16, when the party left for Reno

to attend the exercises on the following day at the opening of the Truckee-Carson irrigation project, the first to be completed under the Reclamation Act.

This article would be incomplete without mention of Mr. J. B. Lippincott, the distinguished and unusually energetic engineer of the U. S. Geological Survey in California, and his assistants. Mr. Lippincott's work has prepared the way for government projects far in advance of what his office would call for. He is eager for California and the west. He possesses the confidence of all the people and invites their coöperation.

The members of the Congressional Committees were enabled to make a most comprehensive itinerary owing to the fact that the Southern Pacific Company placed a special train at their disposal.

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Secretary, The Sierra Club.

"CLIMB the mountains and get their good tidings. Let Nature's peace flow into you as sunshine flows into trees. The winds will blow their own freshness into you, and the storms their energy, while cares will drop off like Autumn leaves."

This is the gospel preached by John Muir for these many years. It has been taken up by the Sierra Club, which was organized in California in 1892 by a number of enthusiastic mountaineers and nature lovers whose thoughts and ideas had become crystallized in the successful effort to establish the Yosemite National Park. John Muir was chosen as their leader and has presided over their counsels ever since. The university of California and Stanford University, through their faculties and alumni, have furnished a large part of the strength and vitality of the club. The corporate purposes are, "To explore, enjoy, and render accessible the mountain regions of the Pacific Coast; to publish authentic information concerning them; to enlist the support and coöperation of the people and the government in preserving the forests and other natural features of the Sierra Nevada Mountains." Its members have made pioneer ascents of almost inaccessible peaks, have explored and mapped large areas of the High Sierra, and have called the attention of the public to the beauty and grandeur of the mountains of California. But its most important work has been in aiding in the establishment of the forest reserves.

President Roosevelt, in his address at Stanford University in 1903, spoke of the Club's work as follows: "California has for many years, I am happy to say, taken a more sensible, a more intelligent interest in forest preservation than any other state. It early appointed a Forest Commission; later on some of the functions of that commission were replaced by the Sierra Club, a club which has done much on the Pacific Coast to perpetuate the spirit of the explorer and pioneer."

Every movement which has for its object the preservation of our forests or our natural scenery finds the club an active champion. It has been cooperating with other organizations which have allied interests and particularly with the various branches of the government service which have

done so much of late years to promote the welfare of the West. Too great praise cannot be given the departments which are handling the tremendous problems involved in forestry and irrigation. The work which has been accomplished in the past few years is almost beyond belief and the plans for the future are only more stupendous.

While the Sierra Club is most heartily and actively in favor of this utilitarian side of the forest and water questions yet we also feel that the æsthetic and ideal features of our mountain scenery require the most jealous guardinanship. This is es-

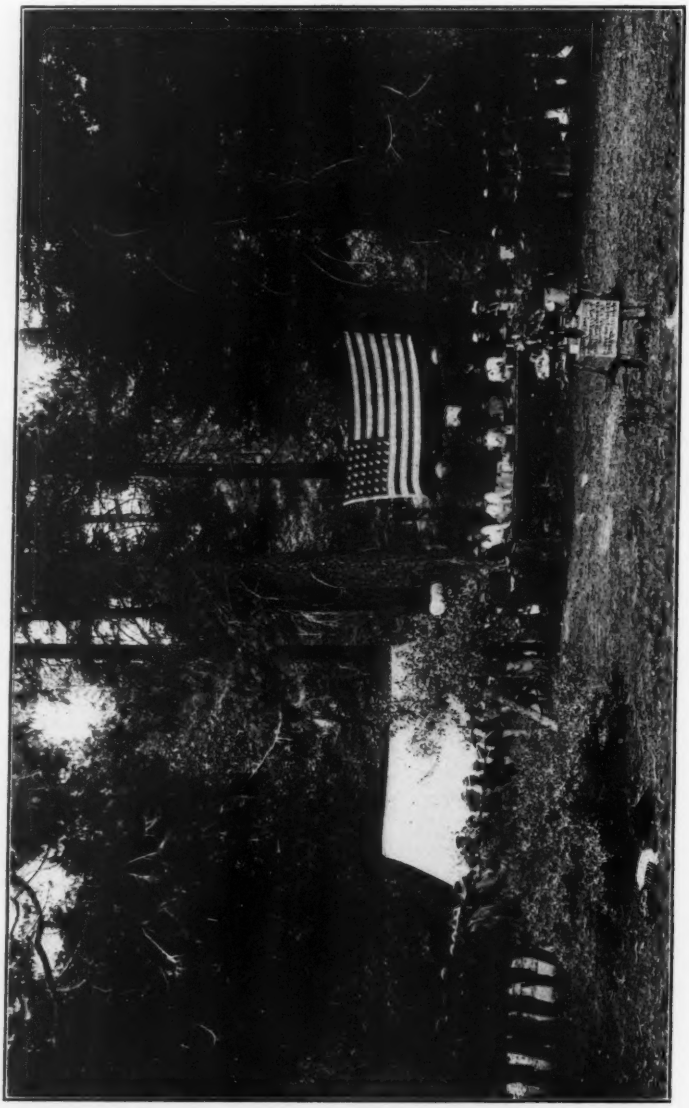

Photo. by Prof. J. N. LeConte

With the Sierra Club in Kings River Canyon

pecially true right now when commercialism is so aggressive. If not carefully watched, power companies would drain our waterfalls and lumber companies fell every giant sequoia that has managed to escape their ravages in the past. As David Starr Jordan, a director of the club for many years, expresses it: "The duty of the Sierra Club, as I understand, is to stand between California scenery and California greed."

Every since the establishment of the Yosemite National Park, John Muir has been working to have the Yosemite Valley, which was a small grant of a few square miles under state control and in the very heart of the national park, made a part of that park. The logic of the proposed change, which would mean merely a relinquishment of the trust by the state; which would terminate the divided jurisdiction, and which would place the Valley under Federal control, where it would be far better cared for and have greater appropriation for its maintenance as well as the undivided attention of expert engineers and officials—was evident to almost every one who gave the matter a moment's thought. But like all other matters of public concern where there are no private interests to be benefited by the change, a great deal of inertia had to be overcome. The club was pleased to note in the July, 1904, number of FORESTRY AND IRRIGATION, an article by President Roosevelt where he stated that "As to the Yosemite Valley, if the people of California desire it, as many of them certainly do, it also should be taken by the national government to be kept as a national park, just as the surrounding country, including some of the groves of giant trees, is now kept." And in his annual message to Congress shortly after, he repeated this sentiment.

The Sierra Club had long been gathering material for this campaign, and, reassured by this expression of opinion by the President and by the Secretary of the Interior and other Federal officials, it printed and distributed information on the subject and interested the leading men of the state in the movement. The proposed transfer was bitterly fought by a few on the alleged ground of state pride, but the better element in the Legislature prevailed and passed an Act re-ceding the Valley to the Federal government. The sentiment of the people was overwhelmingly in favor of recession, as was evidenced by the fact that over one hundred newspapers in the state favored it, while three were opposed. Congress, which was just about to adjourn, appropriated $20,000 for the improvement of the Valley, but, owing to certain technicalities, it is claimed that further Congressional action is necessary before the Valley can be formally accepted. If this be true, it is sincerely to be hoped that it may be done without delay at the next session, in order that this greatest of all our scenic wonders may be properly cared for and rendered easy of access.

The club has recently erected a beautiful memorial lodge in Yosemite Valley in honor of the late Professor Joseph Le Conte who was a charter member and deeply interested in all that pertains to the mountains, and their forests and streams. A library is kept there for the visiting public and information as to the trails and points of interest in the vicinity freely given to any inquirer.

The club, in its endeavor to educate the people to a complete realization of the necessity of preserving our forests and scenic features, has, for several years past, conducted annual outings into the mountains. Even remote and inaccessible points of interest in the Sierra have been visited by these large parties and many of our highest peaks climbed. In 1903 during the Kern River outing, 140 persons reached the summit of Mt. Whitney, an elevation of 14,522 feet. Not one-tenth of that number would ever have been able to make this climb without the aid the club gives in making rough mountain trips easy and pleasant. We are commencing to appreciate the truth of Stevenson's words, "Though we should be grateful for good houses, yet, after all, what house is there like God's out-of-doors?"

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DEPARTMENT OF THE INTERIOR, United States Geological Survey, Reclamation Service, Washington, D. C., August 12, 1905. Sealed proposals will be received at the office of the engineer, United States Reclamation Service, Billings, Mont., until 10 o'clock a. m., September 5, 1905, for furnishing 7,000 barrels, more or less, of Portland cement, f. o. b. cars at works of the bidder. Particulars may be obtained by application to the Chief Engineer of the Reclamation Service, United States Geological Survey, Washington, D. C., or to Robert S. Stockton, Engineer, Huntley, Mont.

THOS. RYAN, Acting Secretary.

DEPARTMENT OF THE INTERIOR, United States Geological Survey, Reclamation Service, Washington, D. C., August 22, 1905. Sealed proposals will be received at the office of the United States Reclamation Service, Roswell, N. M., until 2 o'clock p. m., October 17, 1905, for the construction and completion of earth embankments, involving about 200,000 cubic yards of earthwork and 150,000 cubic yards of overhaul, at a point about 12 miles southwest of Roswell, New Mexico. Plans, specifications and forms of proposal may be obtained by application to the Chief Engineer of the Reclamation Service, Washington, D. C., or to W. M. Reed, Roswell, New Mexico.

THOS. RYAN, Acting Secretary.

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The objects of the Association, as set forth in its Constitution, are as follows:

1. The adoption by the Federal Government of a permanent policy for the reclamation and settlement of the public domain, under which all the remaining public lands shall be held and administered as a trust for the benefit of the whole people of the United States, and no grants of the title to any of the public lands shall ever hereafter be made to any but actual settlers and homebuilders on the land.

2. The preservation and development of our national resources by the construction of storage reservoirs by the Federal Government for flood protection, and to save for use in aid of navigation and irrigation the flood waters which now run to waste and cause overflow and destruction.

3. The construction by the Federal Government of storage reservoirs and irrigation works wherever necessary to furnish water for the reclamation and settlement of the arid public lands.

4. The preservation of the forests and reforestation of denuded forest areas as sources of water supply, the conservation of existing supplies by approved methods of irrigation and distribution, and the increase of the water resources of the arid region by the investigation and development of underground supplies.

5. The adoption of a harmonious system of irrigation laws in all the arid and semi-arid states and territories under which the right to the use of water for irrigation shall vest in the user and become appurtenant to the land irrigated, and beneficial use be the basis and the measure and limit of the right.

6. The holding of an annual Irrigation Congress, and the dissemination by public meetings and through the press of information regarding irrigation, and the reclamation and settlement of the arid public domain, and the possibilities of better agriculture through irrigation and intensive farming, and the need for agricultural education and training, and the creation of rural homes as national safeguards, and the encouragement of rural settlement as a remedy for the social and political evils threatened by the congestion of population in large cities.

DEPARTMENT OF THE INTERIOR, United States Geological Survey, Reclamation Service, July 7, 1905. Sealed proposals will be received at the office of the United States Reclamation Service, Billings, Mont., until 2 o'clock p. m., September 5, 1905, for the construction of the Shoshone dam, spillway, outlet and road tunnels, requiring about 69,000 cubic yards of concrete masonry and about 75,000 cubic yards of excavation, located eight miles west of Cody, Wyoming. Plans, specifications and proposal blanks may be obtained from the Chief Engineer of the Reclamation Service, Washington, D. C., or from Jeremiah Ahern, Engineer, Cody, Wyoming. E. A. HITCHCOCK, Secretary.

DEPARTMENT OF THE INTERIOR, United States Geological Survey, Reclamation Service, July 7, 1905. Sealed proposals will be received at the office of the United States Reclamation Service, Billings, Mont., until 2 o'clock, p. m., September 6, 1905, for the construction of a tunnel approximately 18,000 feet long, and auxiliary works, including about 28,000 cubic yards of excavation in open cut, all located ten miles east of Cody, Wyoming. Plans, specifications and proposal blanks may be obtained from the Chief Engineer of the Reclamation Service, U. S. Geological Survey, Washington, D. C., or from Jeremiah Ahern, Engineer, Cody, Wyoming. E. A. HITCHCOCK, Secretary.

DEPARTMENT OF THE INTERIOR, United States Geological Survey, Reclamation Service, Washington, D. C., July 3, 1905. Sealed proposals will be received at the office of the Engineer, U. S. Reclamation Service, Montrose, Colorado, until 10 o'clock a. m., August 28, 1905, for the construction of about 8 miles of main distributing canal, involving the excavation of 52,000 cubic yards of material and the placing of 20,000 cubic yards of concrete masonry for the conveyance and partial distribution of 1,300 cubic feet of water per second from the mouth of the Gunnison Tunnel, near Cedar Creek, to a point on the Uncompahgre River 9 miles south of Montrose, Colo. Full information may be obtained from the Chief Engineer of the Reclamation Service, United States Geological Survey, Washington, D. C., from the Supervising Engineer of the Reclamation Service, Chamber of Commerce Building, Denver, Colo., or from the Engineer of the Reclamation Service, Montrose, Colo. E. A. HITCHCOCK, Secretary.

DEPARTMENT OF THE INTERIOR, United States Geological Survey, Reclamation Service, Washington, D. C., August 2, 1905. Sealed proposals will be received at the office of the United States Reclamation Service, Montrose, Colo., until 3 o'clock p. m., September 26, 1905, for the completion of the Gunnison Tunnel, involving 27,500 linear feet, more or less, of tunnel, the same being a portion of a system for the diversion of about 1,300 cubic feet of water per second from Gunnison River to the Uncompaghre Valley, Colo. Specifications, form of proposal, and plans may be obtained from the Chief Engineer of the Reclamation Service, U. S. Geological Survey, Washington, D. C., or from the Engineer of the Reclamation Service, Montrose, Colo.

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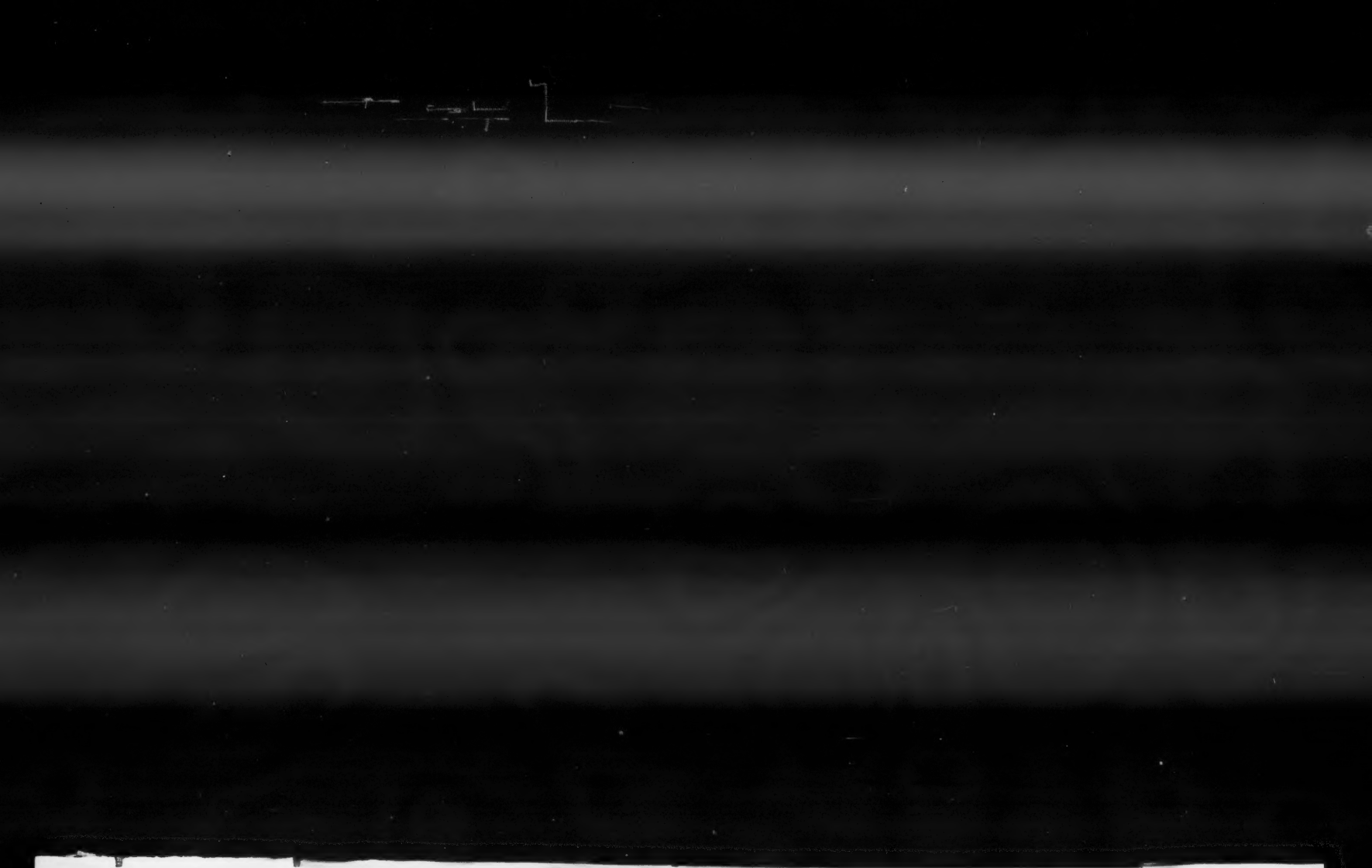
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